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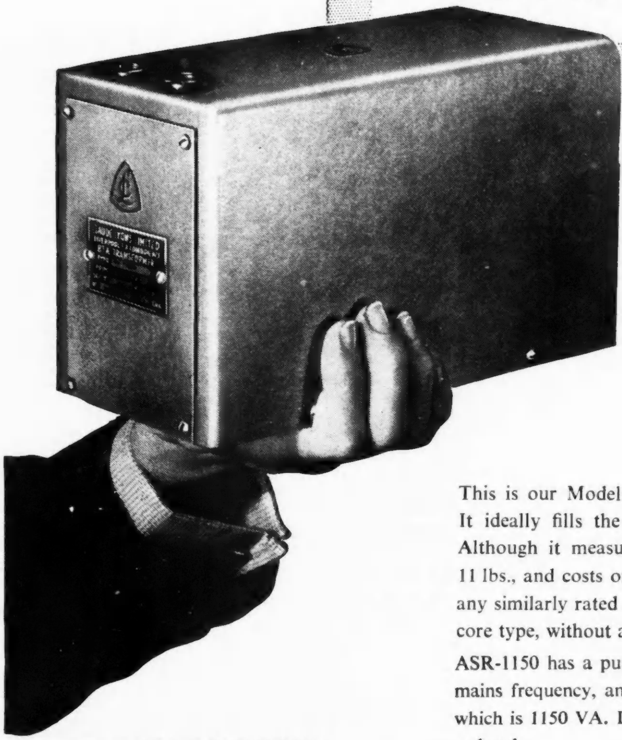

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COVER PICTURE: An artist's impression based on a photograph of the alternating gradient synchrotron which is to produce energy ranging up to 30 billion electron volts. Brookhaven National Laboratory will build it in collaboration with American Universities and the American Atomic Energy Commission.

THE PROGRESS OF SCIENCE

Prof. P. M. S. Blackett, F.R.S., the President of the British Association for 1956–7. Prof. Blackett is well known for his outstanding work in physics, for which he was awarded the Nobel Prize in 1948. During World War II, he directed operational research at the Admiralty, and is now Professor of Physics at the Imperial College of Science and Technology, London. This photograph, specially taken for DISCOVERY, *is of a bronze bust by Jacob Epstein.*

SCIENCE IS NEWS: ANCIENT AND MODERN

"Science is in the News. Come and hear about it from the Scientists themselves", said the poster advertising the British Association Meeting in Sheffield. Since its foundation in 1831, its meetings have turned science into news to fulfil the Association's avowed aim to "bring the objects of science more before the public eye . . . and accelerating its progress". In the past it achieved this aim by being the national platform on which research results were first announced to the public. For years, the national Press gave more space to the scientific news from the B.A. meetings, than to other scientific news throughout the year. It is no mean measure, then, of the success which the B.A. has achieved throughout its 125 years of existence that today the whole climate of scientific thought has changed to such an extent that new means must be sought if its original functions are still to be fulfilled.

Research results are no longer read from the platform of the British Association; they are either communicated to specialised learned societies or published in the greatly fragmented scientific Press which has come into being for this very purpose. Also the popularisation of science is no longer the exclusive privilege of the British Association. The great national newspapers have their own scientific correspondents whose excellent day-by-day reports have brought awareness of scientific research and its social implications to everyone. The BBC has regularly asked eminent scientists to state their views over the air, and television is beginning to take a share in this vital task of bringing science before the public eye. Scientific films, both of the specialised and of the more general kind, have shown audiences since 1910 what science is, and what it means to live in the scientific century. What then is the function of the British Association if research results have ample channels of publication and if the popularisation of science is carried out daily by media of mass communication, themselves the result of much scientific research?

These criticisms of the British Association are not new and have been voiced for several years now during its annual meetings. That they were valid was recognised by the Council of the Association when a "reform committee" was set up under the chairmanship of Sir Ben Lockspeiser; this committee made known its suggestions at the meeting in Sheffield. Basically it reaffirms the objectives of the Association: firstly to offer eminent scientists a platform on which they can discuss their work and thus give some understanding of the integrity and of the discipline of the search for scientific truth; secondly to encourage scientists to discuss their subjects in joint sessions with colleagues from other disciplines and thus to solve common problems

ROTATION OF THE EARTH DEMONSTRATED BY GYROSCOPE AT FARNBOROUGH AIR SHOW

A light beam, issuing from the stationary lamp in the centre, is reflected from a composite mirror, itself mounted on top of the gyroscope on the right, on to the graduated scale on the left. The gyroscope, electrically driven, spins at 23,000 r.p.m. The mirror is made from stainless steel and has twelve sides, so that after 30° rotation of the Earth the light beam will again begin its traverse from the left side of the scale; each time this occurs, roughly after about 2½ hours, a new scale must be provided by an attendant.

on the frontiers of present knowledge; thirdly to provide at its annual meetings an opportunity for stock-taking of the progress of science—in a language intelligible both to the layman and to the scientist outside his own field—and thus to make clear the significance of scientific advance and its consequences. These are indeed admirable aims which all will applaud. Special one-day meetings, streamlining of its journal, *The Advancement of Science*, and an internal co-ordinating committee to bridge the gap between individual sections, are envisaged as the means of achieving the suggestions of the reform committee.

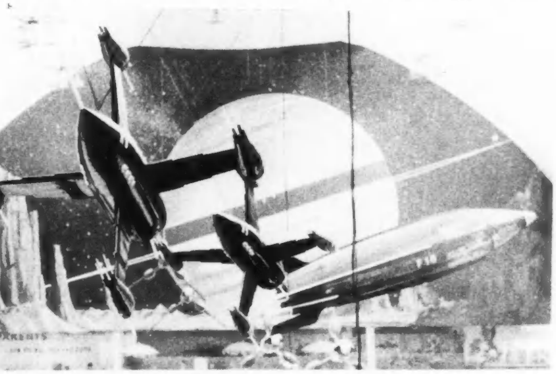
But will these means be sufficient to bring science before the public eye and accelerate its progress? Much will depend in the coming year on the permanent officers and on the new president, Prof. P. M. S. Blackett; of vital importance will be his ability to use his experience in operational research. His task will be to ask the correct fundamental questions and to seek their practical solution in the short year at his disposal. Agreeing on the fundamental objectives, how can they best be achieved? Are the meetings of the Association, both in attendance and in number of papers given, too large, too small, or just right? Is the right kind of person attending these meetings? (To answer this question, each member at the Sheffield meeting was asked to complete a questionnaire.) If certain deficiencies are disclosed from the replies to this questionnaire, how can other sections of the scientific community or general public be attracted to the next meeting in Dublin? Should there be a general theme for the next meeting, or should there be several for joint sessions of a number of sections, and if so what themes? Should these themes be of an academic nature, dealing with the social consequences of science, or be purely chosen because they would have news value? Can science be made intelligible to the layman by speech and writing alone, or should the British Association itself employ the media of mass communication, broadcasting and filming its own message and interpreting it in a way which millions can understand? Is research needed to break the code-language of scientific communications, or can existing knowledge be adapted to bridge the gap between scientist and layman? What can we learn in this difficult task from our colleagues in other countries, from the American and the French Associations for the Advancement of Science? How large should the joint meetings be which aim to accelerate the progress of science by discussing several disciplines and thus cross-fertilise each specialty? Would it be advantageous to have non-scientists take part, and invite politicians, trade unionists, administrators, and civil servants? Or is cross-fertilisation best carried out during a stroll through the laboratory or during a quiet chat over a meal? On the practical solution of these and many other similar questions may well depend the

successful modernisation of the ancient traditions of the British Association. There can be little doubt that such thoughts must already be uppermost in the minds of the permanent officers and of the President; if the Association has succeeded in the past 125 years to be the most important platform for presenting science to the nation, then surely by applying scientific methods to its own affairs it will be able to improve them.

One question which will no doubt exercise the mind of Prof. Blackett and his officers will be a purely financial one. Where will the money come from for these necessary reforms? Undoubtedly, industry will spring to their minds, as the universal benefactor. But industry is unlikely to part with its hard-earned cash unless it can see results from its investments, and often returns must be immediate and not in the distant future. The British Association can take pride in its achievement of making industrial concerns aware of the need for scientists in their laboratories. Unfortunately this need has recently outrun the supply. Industry is very willing to spend considerable sums of money to encourage young boys and girls to enter into a scientific career (see below), and would no doubt help the British Association if it were to include this aim as a major one amongst its others. Trends towards it are noticeable in the School Science Exhibitions at the Bristol and Sheffield meetings of the Association, but because these are held during vacation, they attract only a comparatively small audience. Has the time come when a "Junior B.A." is urgently needed, not only in the interest of industry, but also of the country as a whole? How can the exciting and stimulating message of science be best brought to the attention of the young? Should the special one-day meetings, planned for the future, be entirely devoted to this subject? If the British Association can find a practical solution, then surely industry would be more than willing to support the Association financially and bring its great resources to bear on this vital task.

Just how powerful the resources of industry can be, was brilliantly demonstrated at the annual flying display and exhibition of the Society of British Aircraft Constructors at Farnborough, partly overlapping in time this year with the Sheffield meeting. No expense was spared to demonstrate the results of years of scientific research to a public from Britain and overseas. A large hall housed static exhibits; many runways allowed visitors to walk around the latest aircraft; and a magnificent fly-past of helicopters, of jet-fighters and jet-bombers, and of civil aircraft demonstrated the versatility and power of one of Britain's most scientifically conscious industries. Amongst new items was a demonstration of thrust reversal on a jet-fighter to shorten the landing run, and an airfield control radar display of London Airport, on the Marconi stand at Farnborough, transmitted cross-country by a multi-channel radio link. Delightful also was a demonstration of the rotation of the Earth by the Sperry Gyroscope Company: a light beam from a stationary source was reflected from a gyro-stabilised twelve-sided mirror on to a scale graduated in degrees of rotation of the Earth.

The scene was significantly different from the meeting of the British Association. Pure science has still to learn showmanship if it wants to sell itself as effectively as industry has succeeded in doing. It is essential, if only for one reason: the general taxpayer ultimately pays the bill for pure scientific research, and he is entitled to

A galaxy of space ships suspended from the ceiling of the Olympia Exhibition for Boys and Girls. Through this and other exhibits it is hoped to direct many boys into scientific careers. (*By courtesy of the Central Electricity Authority.*)

know what tune is called. Also the young will be far more attracted by what science can achieve—glittering aircraft engines and supersonic jet-planes—than by what science thinks. And to attract the young to come forward and join in the exciting adventure of scientific research should be the aim of all who have the future of this country at heart. After all, the future is the scientist's business.

Hulton's Boys and Girls Exhibition at Olympia was certainly streamlined towards the future. Suspended from a pale blue ceiling, artificial satellites and a galaxy of space ships directed the view of the young towards large panoramas of the Moon and of Jupiter. Below this exciting prospect of the distant future, many exhibitors were clamouring for more immediate attention and trying to attract boys into scientific careers. The Navy and the Air Force were there with a midget submarine, and Vampire jet trainer; the Central Electricity Authority with a working model of Calder Hall, British Railways with a superb display of toy trains; and British European Airways with a team of engineering apprentices carrying out maintenance on a turbo-prop engine. Industry was certainly not to be left behind in this race for future engineers, physicists, and chemists; ICI featured terylene, silicones, and titanium; the Rank Organisation had a climber on top of Mt Everest with a cine camera; and Vickers-Armstrongs showed its engineering products of today, to get the young to design and build the aircraft and the ships of tomorrow. Nobody, apparently, wanted any girls for a scientific career; for them only the fashion show, the ballet, and nursing. Also absent was any appeal for young biologists, medical research workers, or social scientists; apparently Government Departments and Industry think that the natural supply is sufficient for any future need. Should this imaginative exhibition become a regular annual event, it will be interesting to watch which scientific profession will be most in demand.

If even one future Newton or Rutherford is attracted to a scientific career by Farnborough or by the Boys Exhibition at Olympia, and if he is confirmed in his choice by attending a meeting of the British Association, then Britain will continue to lead the world in modern scientific research as it has done since ancient days.

CALDER HALL: A SUCCESSFUL AFTERTHOUGHT

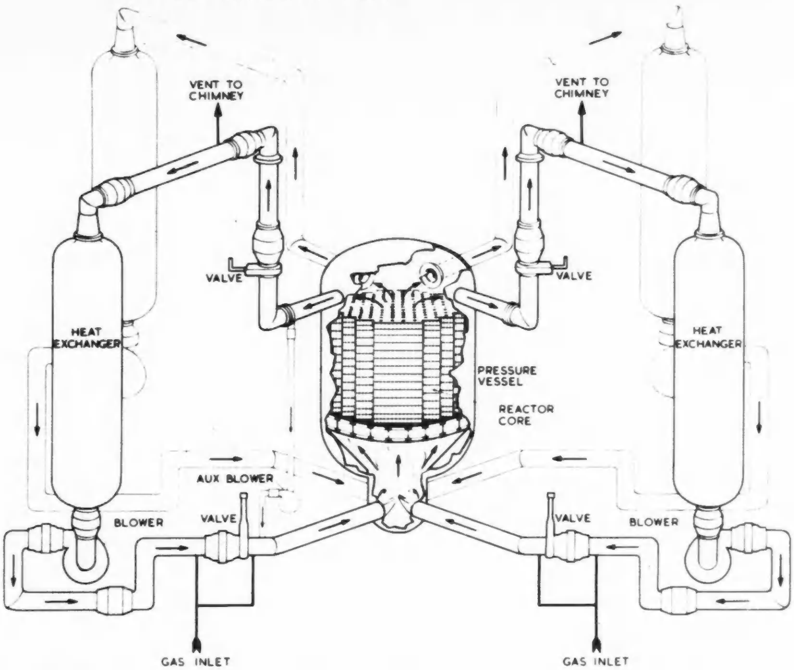
You get to Calder Hall, the new atomic power station on the Cumberland coast, along a narrow country lane that has remained much as it must have been before the war. And when you get there, you do not find a wild jungle of railway sidings. There is, it is true, a railway line a few hundred yards away, but most of the heavy equipment which has had to be carried to the site has come by country lane. Now that the station is working, a few railway trucks will be enough to keep it supplied with fuel from the factory at Springfields in Lancashire. A few trucks will carry away the spent fuel to the processing plant at Windscale, half a mile to the north.

More than any other, this simple fact explains why it is that countries which have no great natural fuel supplies of their own have become excited at the prospect of atomic power. A few tons of uranium can be handled by the simplest transport system: the coal needed to keep an ordinary power station running has to be carried expensively by rail, canal, or sea. It is for the same reason that in the United Kingdom atomic power stations are now being planned in parts of the country which are more than a hundred miles from the nearest coalfield.

But for some years at least, atomic power will be used only in those countries which have the technical resources to build atomic power stations. And in the United Kingdom at least, the first half-dozen or so of these will be modelled on the plant which the Queen will open on October 17.

Taken from the low hills above the station, the picture shows the two Windscale plutonium production piles and the two Calder Hall atomic power stations.

CALDER HALL:
REACTOR GAS FLOW



Calder Hall was not built as a simple power station. When it was designed in 1950 the shortage of plutonium for making bombs had become acute. Calder Hall was meant to produce this explosive in much the same way that the nearby plant at Windscale did. But in 1950 engineers could not bear the thought that all the heat that would be generated at the same time as plutonium should be wasted. They decided to make use of it to generate electricity.

In this way, almost as an afterthought, they ensured that the United Kingdom would become the first country in the world to generate large amounts of electric power from uranium in such a way that it could be supplied to the national system of electricity supply. As things have turned out, their decision has also given the country a substantial advantage over other countries which have the resources to build these power stations. It has also provided the country with what may turn out to be a solution of its now critical shortage of fuel.

In fact Calder Hall is the simplest kind of atomic power station that could have been built. For one thing, the fuel it uses is natural uranium. No expensive plant is needed to increase the content of the fissile isotope U-235 above the natural one of 0·71%.

Physically, each reactor—there are two in the whole station—consists of a large steel cylinder with spherical ends. This has been welded on the site out of mild steel plates between two and three inches thick. This is surrounded by a hexagonal radiation shield which has been poured from special dense concrete into slabs between seven and eight feet thick.

Inside the reactor are more than 1000 tons of pure graphite, machined into blocks which fit together after the manner of a three-dimensional jig-saw puzzle. In this structure there is room for upwards of a thousand rods of uranium to hang vertically in cans of magnesium alloy, and space too for the rods of boron steel which can be inserted into the reactor to slow down or to stop its operation.

When the rods are withdrawn, which is done by remote control mechanisms, the nuclear reaction starts. Fission of atoms of U-235 takes place. Some of the neutrons released in the process go to make plutonium or to induce the fission of other fissile atoms, while the energy released in fission appears largely as heat. This, at Calder Hall, is extracted by a current of carbon dioxide gas at a pressure of 7 atmospheres (about 100 lb. per sq. in.) and fed into four heat exchangers, in principle rather like conventional boilers, in which the heat is used to raise steam. Both the temperature and pressure of this are much lower than in the conventional power station now generally built, but they are sufficient for the steam to be able to drive conventional steam turbines. At Calder Hall the total capacity of these is 92,000 kW, though some of this output will have to be used to drive the fans which circulate carbon dioxide through the reactors.

In such terms the building of atomic power stations sounds a little too simple. In fact, both because of the novelty of the plant at Calder Hall and because of the speed with which it has been built, several difficulties have cropped up during construction. Even now it is probable that some small snags remain, and that these will have to be eliminated after October 17. But it is

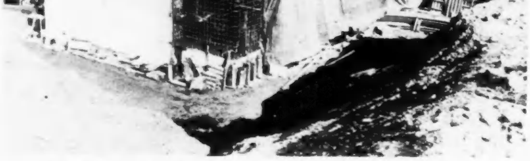
for reasons like these that Calder Hall is especially valuable. It is a gold-mine of experience in quite a new field of nuclear engineering.

In the same way the special value of the operation of Calder Hall, at the beginning at least, is that it will provide valuable information on the best way of running nuclear reactors. How best to press buttons in the control room in order to keep the heat output of each reactor constant? How best to arrange fuel elements in the fuel channels, and how best to charge and discharge these? These are questions that will be answered by the time the next large atomic power station is ready to start up (in 1959 or 1960). By then, too, it will be reasonable to expect answers to the question: How much heat can be extracted from a ton of uranium before sending it back to the works to be reprocessed? This is a question on which much of the detailed economics of nuclear power depends.

For reasons like this, the Atomic Energy Authority will rightly be pleased with itself for having decided to build Calder Hall. In particular, the design team at Risley and the Works Manager at Calder Hall—Mr H. G. Davey—deserve all honours for a fine engineering achievement. So too do all the people, in research laboratories or on the site, who have helped to translate a plausible dream into tangible reality in the short space of five years.

ATOMIC POWER IN AMERICA

Britain will be the first country to produce atomic power on a large scale, but the Shippingport plant in Pennsylvania, U.S.A., will be the first of its own kind, being designed to make nothing but electricity. Sir Edwin Plowden, Chairman of the British Atomic Energy Authority, recently spent a week seeing atomic power sites and laboratories in the United States, including the Shippingport plant, which is a joint project of the U.S. Atomic Energy Commission and a private electricity generating firm. Westinghouse Electric Corporation is building the atomic reactor.



The concrete casing rises around one of the two boilers installed in the pressurised water reactor at Shippingport, Pennsylvania. This picture shows the constructional progress made by the middle of January this year.

The Shippingport plant uses a pressurised water reactor, a system in which water is used as both the moderator and the coolant. Nevertheless, the reactor and the steam generators will be enclosed in pressurised gas-tight containers capable of preventing the radioactive products of a possible accident from escaping. The primary loop, 2000 p.s.i., will be located underground. The inlet temperature to the steam generators will be 525°F. The steam generators will produce saturated steam at 600 p.s.i. The core will comprise a compact latticework of zirconium-clad fuel elements. Control will be by a fairly simple arrangement of vertical rods.

Although it would have been cheaper to build a conventional power plant, it was agreed that this venture in the peaceful application of atomic energy justified the extra cost. While the basic objective is to demonstrate the reliability rather than the cheapness of nuclear power, the Shippingport plant will provide a firm basis for estimating costs. With the knowledge gained from this plant it will be possible to estimate the cost of constructing and operating plants of the same type on a non-developmental basis. Furthermore, such costs as those for fuel fabrication and safety devices in construction will undoubtedly be reduced by the knowledge gained in the operation of this plant. Pressurised water units will then ultimately have a good chance of becoming competitive.

RESEARCH FOR WHOSE SAKE?

There exists a nice balance in Great Britain between theory and practice: on the one hand universities exist as extra laboratories working for industry; on the other there is the extreme remoteness of the university scientist, the protagonist of Sir Edward Appleton's story, who thanked God every day that the work he was doing was not and could not be of any use to anybody. We are at least led to believe that balance exists, and we congratulate ourselves with the comforting, slightly pharisaical platitudes about our unique genius for compromise and the importance of the middle way. Is this picture entirely true to life nowadays?

A report called "Scientific Research in Universities and Industry"* has appeared recently. It deals solely with conditions in Great Britain and sets out the results of a careful scrutiny of the universities' relations with industry. It is a sober, if not an agonising, appraisal. The whole of the information in the report was obtained by means of questionnaires, the response being about fifty per cent. It is written in a flat style typical of this kind of report, so that reading it is something of a chore. The report poses a great number of problems and has no solutions to offer. It is an unemotional call to arms.

The organisation of research in Great Britain is first thoroughly described, though there are some inexplicable lapses. For example, the number of staff belonging to the DSIR, and its finances are given for the year

* Published by the International Association of University Professors and Lecturers with some aid from UNESCO. 187 pp. Price 15s.

1950–1. More recent information is available in public documents and, in fact, is quoted elsewhere in the report. There is also an out-of-date (by some years) list of Research Associations. However, the groundwork is laid for discussion in the two later and far more interesting sections of the report.

There appears to be nothing much wrong with the interchange of ideas and information between industry and the universities. About twenty per cent of the work done in departments of science and technology is being carried out for industry, either direct or through the Research Associations, and about the same percentage of consultative work is done for industry by teachers in these departments. Industry and the universities exchange information and spirit by means of summer schools and other methods. The report comes to the conclusion, though, that the universities could well do with more money from industry to get on with their work, money with no strings attached. Of course this view may not be so acceptable to industry.

The main problem facing the universities, without a doubt, is the increasing demands for aid in answering scientific and technological questions by Government and industry. This growing pressure produces immediate difficulties. Funds for the support of research, concentrated obviously on the subjects important at the moment, can have serious effects on the work in universities, for example by stressing certain scientific disciplines (say the physical sciences) against others, or by excluding the humanities and social sciences. This is a real danger, for in some departments more money is obtained from outside than from the university itself. The tail can start to wag the dog. There is a certain safeguard in that research work in universities is more often than not the result of individual action, and there is not the pressure of a Federal authority as there is in the U.S.A., which does not possess the Government laboratories that this country does. Nevertheless a study of the situation has been made at Cambridge, where the danger signals have been recognised, and other universities may be expected to follow this lead.

There are many points which come to mind immediately and are discussed in the report. What effect do outside contracts have on the autonomy of the universities and on their fundamental work? How much should be paid to individuals? Should a university accept secret work? And so on. These problems and a host of others are considered in dispassionate detail. There is an urgent need for discussion of these issues. The questions raised are perhaps obvious, but few people are thinking about them yet. That is the report's value. It should start the ball rolling.

ALTERNATING GRADIENT SYNCHROTRON

In January, 1954, the United States Atomic Energy Commission approved the design and construction at Brookhaven National Laboratory, Upton, New York, of an ultra-high-energy particle accelerator for nuclear research. The new machine, an alternating gradient synchrotron, is designed to produce beams of protons of energies ranging up to 30 billion electron volts.

As a means of producing nuclear reactions under controlled conditions on a laboratory scale, particle accelerators have played an important role in the advancement of nuclear science and have contributed much of the fundamental scientific information used in the design of nuclear reactors. The energy of the particle beams produced by accelerators bears a direct relationship to the nuclear phenomena that can be studied. As higher energy levels have been attained in laboratory machines, new information has been gleaned regarding the nature of the fundamental nuclear particles, neutrons and protons, new sub-nuclear particles have been discovered and new nuclear phenomena observed.

The alternating gradient synchrotron will use a series of alternate, strongly converging and diverging magnetic fields to confine a proton beam in a tube of relatively small cross-section. This focusing effect allows the production of high energy beams with smaller electromagnets and related equipment than would otherwise be possible. The Brookhaven Alternating Gradient Synchrotron will start the protons toward their ultimate energy by means of a 50 million electron volt linear accelerator which will be approximately 110 feet long. This machine will inject the protons into the circular synchrotron magnet which will not only guide the particles in their circular orbits but also keep the particle beams strongly focused. The overall circumference of the magnet ring is half a mile, and about 3500 tons of steel will be required to build the 240 magnets which make up the ring. The protons will make approximately 300,000 revolutions of the doughnut-shaped vacuum chamber, which again is about half a mile long and has an elliptical cross section of about 9 inches by 3·5 inches. During each one of these revolutions the energy of the protons is increased by roughly 100,000 electron volts by means of twelve radio-frequency accelerating stations which are periodically located around the synchrotron ring. The actual design, development, and construction of the Brookhaven Alternating Gradient Synchrotron has been in progress since January 1954 and is being carried out by a group of about 100 people. The first of the buildings to be associated with the machine is about 60% complete, and the trench for the magnet ring has been dug and pilings driven. It is now expected that the machine will be in operation some time in 1960.

The cost of design and construction of the new accelerator is estimated at $26,000,000. Once in operation it will be available to scientists wishing to collaborate in Brookhaven research programmes or to carry out independent programmes.

Brookhaven National Laboratory, a research centre equipped with facilities which no single university could afford to build or support, is operated for the AEC by Associated Universities, Inc., a corporation sponsored by nine north-eastern universities. The institutions are Columbia University, Cornell University, Harvard University, Johns Hopkins University, Massachusetts Institute of Technology, Princeton University, University of Pennsylvania, University of Rochester and Yale University.

A drawing based on a photograph of a model of the synchrotron appears on the cover of this issue.

RESEARCH AT THE WEIZMANN INSTITUTE

A conference met in London in July to review the progress of Israel's Weizmann Institute of Science during the past ten years. It was attended not only by those responsible for the Institute's remarkable record of fundamental research in many branches of the physical sciences, but also by members of various "lay" associations in Britain and the United States which generously provide a substantial proportion of the funds upon which the Institute in Rehovoth relies. The advance documentation was admirable, as indeed it needed to be if the non-technical delegates were to grasp at least the major implications of the investigations now being pursued.

Research being carried on by the Department of Isotopes aroused much interest. Rehovoth is the only place in the world producing highly enriched oxygen isotopes, including O–17 and O–18; and is now recognised as the leading authority on the use of heavy oxygen. The problems of isotope separation, originally studied in designing a plant for the production of heavy isotopes of oxygen, are being resolved in a manner which gives results applicable to all processes involving counter-current operations, including the large-scale, inexpensive production of heavy water by electrolytic processes. The work now being carried on both with stable and with radioactive isotopes includes the detection and measurements of tiny amounts of radioactive chlorine produced in rain water by the action of cosmic rays. (Incidentally, in the field of cosmic radiation, the Department of Nuclear Physics can claim the discovery of a new particle, and has made a thorough study of the nuclear collision in which this particle was first observed photographically.)

The work which is being done in the Department of Experimental Biology on the mechanism of tumour-formation promises to introduce a new approach to certain aspects of cancer research. For the last fifteen years it has been known that tumour-cells could remain in a latent or dormant state: and this led to the discovery that the origin of a tumour involved two successive processes: the conversion of a normal cell into a dormant tumour-cell: and the slow evolution of the dormant tumour-cell into a recognisable, established, growing tumour. Recent investigations have established this underlying principle on a quantitative basis, following independent discoveries that croton oil is a powerful "promoting" agent and that urethane can be used as a pure "initiating" agent. The results formerly achieved by repeated applications of a "complete" cancer-producing agent can now be attained by a single application of urethane for initiating, followed by successive applications of croton oil for promoting, action. The current investigations are based upon the further discovery that urethane can act as an initiating agent for the skin even when fed by mouth. This means that the process involves the conversion of the urethane into some chemically changed product, which is no doubt the effective initiator. The search for this "metabolite" is now being pursued both by biochemical and chemical methods: and the real significance of these new developments lies in the fact that the mechanism of tumour-induction, previously regarded as a purely biological problem, now lends itself to biochemical investigation and treatment.

The particulars furnished to the delegates of the London Conference covered a great many other aspects of the Institute's work, such as—to take only one example—the successful electronic computer constructed at Rehovoth, which now works three eight-hour shifts every day to deal with the problems fed to it not only by the various departments of the Institute, but by technical branches of the Israel Government and by many commercial undertakings. In view of the obvious practical utility of several of the striking advances in "pure" science achieved by the Institute, critics who have sometimes complained that too much time and money are expended on the problems of basic, as contrasted with applied, research, were completely satisfied. The Conference endorsed the programme suggested for further lines of research up to March 1960; made highly practical plans for raising the necessary funds; and endorsed a scheme for reorganising the administrative side of the Institute to keep pace with the rapid growth of the expanding scientific departments, many of which now occupy an international position which transcends even their immediate importance to Israel. This result must be considered highly encouraging to all those who have worked so devotedly to build up a true scientific tradition along the lines which Dr Weizmann pioneered. He would have been proud of what his successors have accomplished.

PSYCHOLOGY, OLD AND NEW

"Witch Doctors and Psychoanalysis" is the title of an interesting article by Claude Lévi-Strauss in the *UNESCO Courier* for July–August 1956. The author describes how the Cuna Indians of Panama cure cases of difficult childbirth and other more evidently psychological disorders by methods "strangely reminiscent of psychoanalytical treatment". Lévi-Strauss also recounts the experience of Dr Kilton Stewart, an American psychologist who has written a book, "Pygmies and Dream Giants" (New York, 1954), in which he describes his work in the Philippines with a pygmy tribe called Negritos. Dr Stewart admits that in certain respects the psychotherapy used by the Negritos is ahead of our own.

According to Lévi-Strauss, the creation of a myth is part of the treatment used by these so-called "primitive" peoples, and he adds, "The difference is that with the Cuna the myth is ready-made, familiar to everyone, and perpetuated by tradition, the witch-doctor merely adapting it to each individual case. . . . In psychoanalysis, however, the patient elaborates his own myth. When we stop to think about it the difference is not so great, since psychoanalysis reduces the causes of psychological disorders to a very small number of possible situations from which the patient can choose, but do little more."

It does seem, however, that there must be a very big and fundamental difference between a myth "ready-

made and familiar to everyone", and one created by a patient out of his own sick mind. Traditional myths have a quality of eternity: their truth continues, and that is why they are remembered from generation to generation. It is this quality of stability which makes it possible to compare myths belonging to different and widely separated peoples: the Old Testament flood, and the Mexican myth of the destruction and creation of five different "Suns", for instance. Their underlying similarities suggest that myths have been created by wise men and not by deranged individuals.

Of course it is true, as Lévi-Strauss points out, that other individuals can play a part in our private "myths", because "the critical situations in which individuals are liable to find themselves in our society are, broadly speaking, the same for all". However, our common fund of experiences may emanate from widely different sources. As children we may have felt small and lonely because we have suddenly looked up at a night of stars, or merely because some playmate has walked away with our toys and left us frustrated and cross. We may have found part of the answer to our problem in a poem, or in the sulks. Traditional myths have tended to draw upon the saner of our shared experiences; whereas our lunacies are all too likely to appear in our private ones. The two types of experience may be common to us all; their ingredients are very different.

Dr Stewart was once trying to rouse a patient from a "waking dream in which he was giving a haphazard account of incidents in his past life", when the Negritos stopped him. To be definitely cured, they said, the spirit of sickness must bestow a gift on its victim in the form of a new drum beat, a dance, or a song. According to tribal theory, it is not enough to remove the social inferiority attributable to the illness: it must be transformed into a positive advantage, a social superiority comparable with that which we see in the creative artist. This idea is very interesting; it does seem that it is not enough merely to cure a patient of mentally abnormal symptoms; if something constructive is not put in their place, nothing very much can be achieved.

There is also the problem of deciding who is mad, and perhaps the "new drum beat", the "dance", or the "song" may represent true sanity. As Lévi-Strauss points out, we have treated many geniuses, such as Gérard de Nerval, van Gogh, and others, as psychotics. "At best," he says, "we are sometimes prepared to pardon certain follies because they are committed by great artists. But even the poor Negritos in the jungles of Batan are far ahead of us in this respect, for they have realised that one means of remedying a mental disorder . . . is to transform it into a work of art. . . . We have much to learn, therefore, from primitive psychiatry."

RESEARCH AT HYPERSONIC SPEEDS

B. D. HENSHALL

National Physical Laboratory, Aerodynamics Division

The author served in the RAF from 1947 to 1949 and then attended Bristol University, where he qualified B.Sc. with first-class honours in aeronautical engineering in 1952. He held the Busk Studentship in Aeronautics (administered by the Royal Aeronautical Society) from 1952 to 1954, and was awarded his Ph.D. the following year for his thesis on "Some Aspects of the Use of Shock Tubes in Aerodynamic Research". He joined the Aerodynamics Division of the National Physical Laboratory in October 1954.

The work here described has been carried out as part of the research programme of the National Physical Laboratory, and this paper is published by permission of the Director of the Laboratory.

Recent rapid progress in missile design has increased the need for fundamental knowledge of air flow at extreme speeds of the order of 10–20,000 miles per hour. Such speeds are usually described in terms of the local Mach number M, which is defined as the ratio of the body velocity (or the air velocity if the body is stationary relative to the observer) to the local speed of sound. The two-stage V2-WAC rocket launched at White Sands, U.S.A., in 1949 reached $M=7{\cdot}5$ at the end of fuel burning, an intercontinental ballistic missile with a range of 4000 miles would attain $M=14$ whilst a rocket escaping from the earth must achieve $M\sim35$ at similar all-burnt conditions.

LABORATORY PRODUCTION OF HYPERSONIC SPEEDS

Several methods for the production of flows at hypersonic speeds ($M>5$) are available, and each technique has certain advantages and disadvantages. Free flight testing is impractical because of cost and complexity; and ballistic tunnel ranges, where the model is fired into a supersonic airstream, require a special hydrogen-powered gun to produce the required muzzle velocity. Continuous-flow hypersonic wind tunnels of conventional type require large compressor pressure ratios and extensive heating and cooling equipment, but experimental observations are comparatively simple since the model under test is stationary. Alternatively, the hypersonic shock tube requires complex electronic equipment to collect the test data during the few milliseconds duration of steady flow about the model; however, costly compressors and heaters are not required—yet free-flight stagnation temperatures of the order of 15,000° K may be achieved. It is these latter facts which have led to the rapid development of the hypersonic shock tube in the past five years.

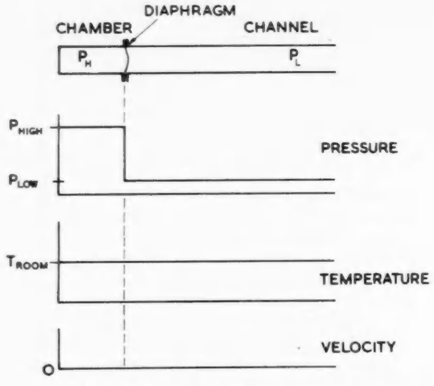


FIG. 1. The simple shock tube before rupture.

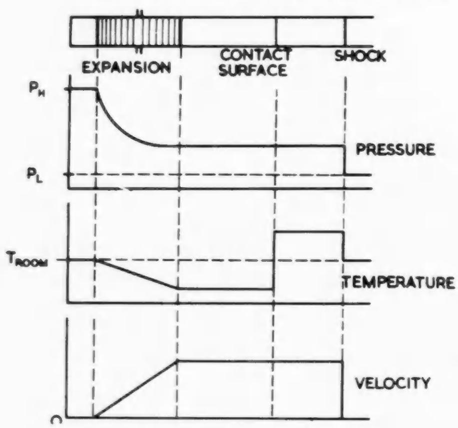


FIG. 2. The simple shock tube after rupture.

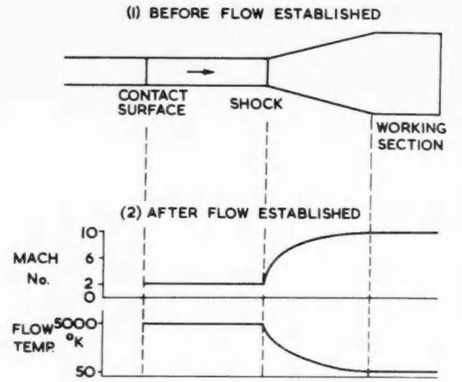


FIG. 3. Hypersonic shock tube.

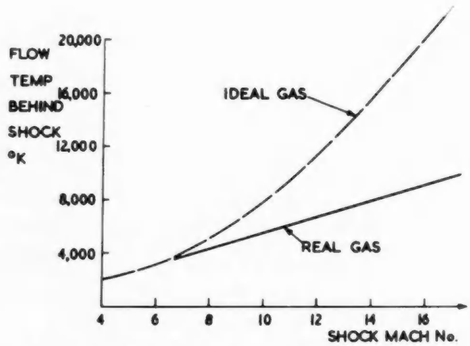


FIG. 4. Real gas effects calculated for pressure corresponding to an altitude of 100,000 feet. Maximum attainable flow temperature shown for ideal gas and real gas.

PRINCIPLE OF HYPERSONIC SHOCK TUBE

Figs. 1 and 2 illustrate the flow processes which occur in a simple shock tube. When the diaphragm is ruptured, an expansion wave is propagated into the gas initially at the higher pressure in the chamber, and a normal shock wave moves into the gas at rest in the channel. The gas particles in the channel are compressed behind the shock and acquire a uniform velocity in the same direction as the moving shock. The expansion wave accelerates the gas particles in the chamber and, with the exception of this acceleration region, all the gas particles in the shock tube are at rest or in uniform motion in the shock direction.

Since the gas behind the shock has been compressed, its temperature is above room temperature; and since the gas behind the expansion wave has been expanded, its temperature is lower than room temperature (Fig. 2). Consequently, a discontinuity of temperature occurs at those coincident points in the uniform gas flow which were originally on either side of the diaphragm. This "contact surface" is therefore a temperature and hence a Mach number discontinuity, but is evidently not a velocity discontinuity.

In the simple shock tube, the Mach number of the steady flow between the shock wave and the contact surface tends to a limiting value of 1·89 for very strong shocks. If an expansion nozzle is placed at the end of the parallel channel a very high speed flow can be generated. Fig. 3 illustrates that the flow Mach number increases down the nozzle whilst the flow temperature falls from the very high value behind the shock in the unexpanded flow (Fig. 4) to the value appropriate to hypersonic flight in the stratosphere (about 200° K). In Fig. 4 the shock Mach number M_s denotes the ratio of shock velocity to the local speed of sound ahead of the shock, and M_s depends on the initial pressure ratio across the diaphragm and the gases used in the chamber. Shock Mach numbers of 15 may be produced by pressure ratios of 10^4 and a combustible mixture of hydrogen and oxygen in the chamber. The stagnation temperature of any hypersonic flow is approximately twice the vertical ordinate of Fig. 4 for any given shock Mach number. The real gas effects curve shown in this figure takes into account the effects of ionisation and dissociation on the properties of air at very high temperatures.

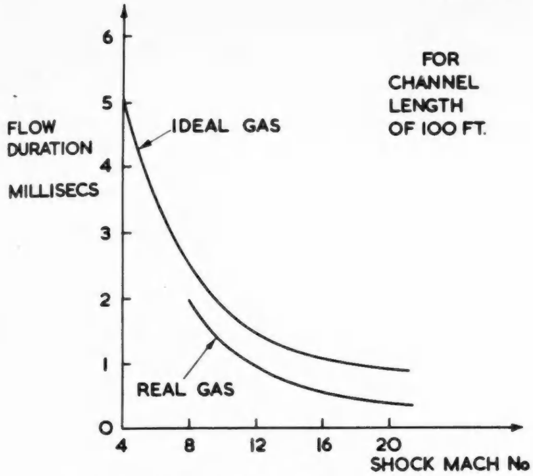


FIG. 5. Duration of flow in hypersonic shock tube.

MODEL POSITION	MACH No.	VELOCITY Ft/sec	TEMP. °K	STAG.^{N} TEMP. °K	$\rho d / \rho_0$	M_s
UNEXPANDED FLOW d=1/8FT.	1·86	10,750	7,450	12,700	7×10^{-2}	14·9
FIRST EXP. d = 1/4 FT.	3·04	13,400	4,450	12,700	4×10^{-2}	14·9
SECOND EXPANSION d = 1/2 FT.	10	6,500	97	2,020	5×10^{-2}	5·6
	10	11,200	291	6,100	5×10^{-3}	10·2
	10	16,200	605	12,700	5×10^{-4}	14·9
	17·8	16,500	199	12,700	3×10^{-5}	14·9
FREE FLIGHT d = 4 FT. 272,000FT.	17·8	16,500	199	12,700	4×10^{-5}	—
106,000FT.	16·4	16,500	231	12,700	4×10^{-2}	—

FIG. 7. Simulation of free-flight conditions in shock tube.

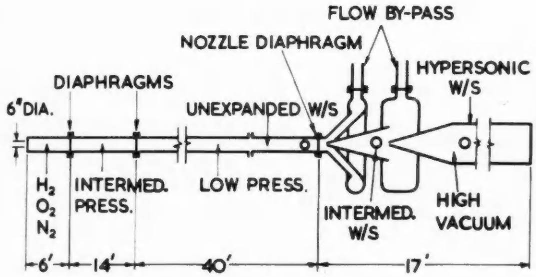


FIG. 6. Proposed NPL hypersonic shock tube.

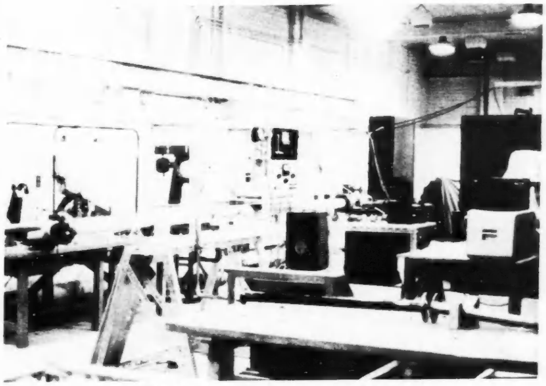


FIG. 8. Photograph of the "gauge" tube.

In practice, not all the flow in the channel passes through the hypersonic nozzle; a large proportion is by-passed to atmosphere via blast tubes round the test section. This alleviates the viscous effects of the boundary layers on the channel walls.

During the passage of the primary shock through the hypersonic nozzle, a secondary shock and a secondary contact surface are formed. These are swept downstream after the primary shock and a region of steady flow at high Mach number ensues until the arrival of the primary contact surface. The duration of this flow depends on the shock Mach number and the length of the channel; typical values for a channel 100 feet long are given in Fig. 5.

To sum up, the hypersonic shock tube can simulate some or all of the conditions applicable to flight of missiles at extreme speeds in the upper atmosphere.

THE NPL SHOCK TUBE PROGRAMME

Fig. 6 is a schematic diagram of the proposed hypersonic shock tube which is at present scheduled to be completed by mid-1958. The chamber and channel are constructed from surplus gun barrels, 6-inch inside diameter, 16-inch outside diameter, and are stressed to 1000 atmospheres pressure. The first expansion is a 3-dimensional truncated cone and the second expansion is 2-dimensional. Provision is made for three working sections, (*a*) in the unexpanded flow in the channel, (*b*) after the first expansion when $M \simeq 7$, and (*c*) after the second expansion where $M \simeq 20$.

Fig. 7 gives some details of simulation calculations made for this proposed installation. The upper limit of the atmosphere is 272,000 feet and the atmospheric density is 1/100 sea level density at 100,000 feet. The parameter $\frac{\varrho d}{\varrho_0}$ is a convenient similarity parameter for flight at extreme speeds. It will be noted that a range of variables is available for each case of interest and although complete simulation is almost always impossible, much relevant information may be obtained from hypersonic shock tubes.

At the NPL a $\frac{1}{2}$-scale pilot model of this large hypersonic shock tube has been built, but with only the first 3-dimensional expansion section. This shock tube is used to aid the development of pressure gauges, temperature gauges and associated electronic equipment for the larger hypersonic installation. Fig. 8 is a photograph of this "gauge" tube.

TEKTITES, METEORIC GLASS

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Washington, D.C., U.S.A.

Tektites, or small glass objects reported as probably of extra-terrestrial origin have long been of great interest to scientists. None has been seen to fall to the earth from outer space, but certain considerations indicate they could not have been formed on the earth. Occurring in great quantities in many places over the earth's surface, they have been collected from time to time as curios or else used as ornaments. The cave dwellers of paleolithic times often used them in the construction of weapon points.

These little glass objects, known as australites when found in Australia, rizalites in the Philippines, bediasites in Texas, moldavites in Bohemia, billitonites in Borneo, and by other names, including Darwin and Libyan Desert glass, usually vary in size from a fraction of an ounce to almost a pound in weight. In shape they range from irregular and unusual to such symmetric forms as buttons, spheres, ovals, pears, dumbbells, teardrops, winged bodies, rods, discs, etc. In colour, although the recovered object usually appears black to a dark shade of green, thin polished sections range from nearly clear through various shades of green to amber or brown. The specimens found in each locality, usually spread over an extended area, such as the south half of Australia and a number of the adjacent islands in the case of the australites, have common characteristics that indicate original association or common source. Similarly, specimens found in other localities possess sufficient chemical and physical differences to establish them as independent sub-family groups in each case.

COMPOSITION AND ORIGIN

A study of the compositions and other characteristics of these glasses has revealed many facts that form the basis for interesting deductions regarding their origin. They have a high silica content with the major secondary constituents being the oxides of aluminium, iron, magnesium, calcium, sodium, and potassium (see Table) and resemble in composition neither any igneous rock structure of the earth (they differ radically from obsidian) nor that of any glass produced since the beginning of glass manufacture. Although certain sedimentary rocks within the earth's crust approximate their composition it is generally agreed that no natural heat source has existed upon this earth within recent geological time capable of producing temperatures sufficiently high to fuse this type of glass, especially since its melting point is nearly 200 C above that of presently manufactured Pyrex glasses.

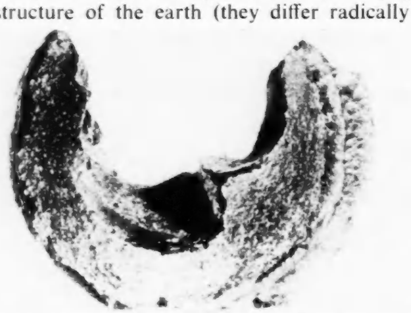

FIG. 1. Fragment of australite illustrating a winged tektite having an apron resulting from partial fusion in flight. (*Courtesy of Wm. A. Cassidy, South Australian Museum, Adelaide.*)

These facts, together with the many special shapes encountered, indicate a flight through the earth's atmosphere at a velocity sufficient to ablate their surfaces. The winged types, in particular, present an unchallengeable proof that the glass surface has been heated to the liquid phase and simply blown off the rear of the specimen forming a circular apron at its base. Fig. 1 shows a fragment of such a tektite picked up in Australia. In fact many stony meteorites also show a glass-like flow over their surfaces. Hence, tektites must be travellers from outer space as are the other types of meteorites.

METEORITES

Ordinary meteorites arrive at the earth's surface in all manner of sizes and shapes. They arrive at various speeds not exceeding about fifty miles per second as determined by visual and radio measurements on their velocities and directions. Most of them, at least, must therefore be following elliptical orbits and are a part of our solar system. Their compositions vary in unbroken sequence from that of nickel-iron to stone that is similar to certain types of terrestrial rocks. (No meteorite, however, is anything like a granite or the acidic volcanic rocks.) These and other observations made during the past century support the suggestion made by Boisse in 1850 that a study of meteorites should result in an understanding of the earth's structure and composition since they possibly came from a former planet having physical and chemical characteristics similar to that of the earth. Today few scientists doubt the hypothesis that meteorites were once a part of a parent planet (or planets) which circulated around the sun in a fashion similar to the observed motions of the remaining planets of our solar system.

Tektites differ from other meteorites in two important ways. First, they are of glass—a very special glass—having a high melting point, a low coefficient of expansion, and a high durability. Second, they are found only in small pieces and usually in special shapes.

Let us try to answer the question of their formation first—that is, how and where. Studies of the many meteorites which have landed upon the earth, many of which may be observed in various museums throughout the world, support the hypothesis that they were once a part of a planet or other cosmic body. In the development of these parent bodies it is to be expected that the

SOME TEKTITE GLASS COMPOSITIONS, SPECIFIC GRAVITY, AND INDEX OF REFRACTION DATA AS REPORTED BY VIRGIL E. BARNES

Glass	Billitonites	Australites	Philippines	Indochinites	Bediasites	Moldavites	Darwin Glass	Libyan Glass
SiO_2	70·30	70·62	71·20	72·26	77·76	80·73	86·34	97·58
Al_2O_3	12·77	13·48	13·52	13·18	13·30	9·61	7·82	1·54
Fe_2O_3	0·53	0·85	0·59	—	0·37	—	0·63	0·11
FeO	5·43	4·44	3·89	5·32	3·36	1·93	2·08	0·23
MgO	3·74	2·42	2·23	2·15	1·19	1·59	0·92	tr
CaO	2·37	3·09	3·40	2·42	0·04	2·13	0·05	0·38
Na_2O	1·73	1·27	1·59	1·43	1·41	0·37	0·15	0·34
K_2O	2·48	2·22	1·84	2·15	1·97	3·60	0·87	—
H_2O	0·08	0·07	0·63	0·20	0·02	0·02	0·46	0·10
TiO_2	0·50	0·90	0·92	0·99	0·76	0·32	0·52	0·21
MnO	0·13	0·42	0·08	0·10	0·01	0·07	—	tr
Total %	100·06	99·78	99·89	100·20	100·19	100·37	99·84	100·49
Sp. gr.	2·48	2·454	2·436	2·44	2·357	2·343	2·296	2·208
N_{Na}	1·527	—	—	1·5133	1·492	1·487	1·474	1·4624

(N_{Na} is a symbol for index of refraction at the sodium lines.)

process was one of the slow accumulation of the cold particles and gases composing the cosmic dust. The bodies would originally be cold, but heat would gradually develop as the planetoid's mass is increased. Heating would result not only from the dissipation of potential energy in the contracting process but from radioactivity and chemical reactions supplemented in a small way by radiant energy from the sun. As a result the planetoid would become heated—the magnitude of the resultant temperature and the degree of the settling and/or boiling processes depending upon the masses involved. For a planet of the earth's order of magnitude it has been estimated that the temperature would reach, or exceed, 3000° K. If the temperature should reach a level sufficiently high to melt the major components of the planetoid, it is expected that there would result a concentration of the heavier materials in the planet's core, with lighter and lighter material tending to attain chemical and physical equilibrium at higher levels as the various chemical reactions were concluded. Thus the lightest substances, the glasses and glassy silicates, would become concentrated in layers or pools on or near the surface of the planet. If the planet had been small, that is of the order in size of the moon or the planet Mars, the materials composing it would have accumulated without appreciable chemical separation as has been the case with those members of the solar system. Hence, to account for the resulting temperatures and separations of the different metal and stony phases (illustrated by the different types of meteorites) a planet approximating the earth in size and general physical and chemical characteristics is required.

From the above picture we have a planet with a nickel-iron core surrounded with troilite (principally ferrous sulphide) and olivene (a magnesium and iron silicate) and topped with the glassy silicates and glasses. The glasses should be uppermost, that is on or near the surface. After the outer crust had been formed volcanic processes similar to those within the earth would be expected to be operative. Indeed meteorites in various museums clearly show that the process by which they were formed was very complex. There was extensive mixing, crushing, melting, segregation and remelting, etc. In fact no theory has yet been proposed that will account for many of the different structures displayed by polished surfaces of meteorites.

No sedimentary rocks, such as shales, limestone, etc., nor structures proving the presence of any type of plant or animal life have ever been observed in any meteorite found anywhere. That is, no water erosion or organic chemical reactions have left traces within any meteoritic material. Although carbon compounds have been reported, carbon in meteorites is always found in an inorganic form. The carbon may be present in combination with N, O, H, S, and Cl or as carbide, graphite, diamond, or as amorphous carbon. If this meteoritic planet was originally located between the orbits of Mars and Jupiter, temperature conditions would have been such that any water present would necessarily have been in the solid state (ice). Therefore surface glass formations should have remained somewhat in their original state. The fact that some of the sedimentary material near the earth's surface approximates the tektite glasses in composition may indicate that the surface layer of the earth was once of similar glassy structure which became eroded and transformed into the sedimentary rocks.

FUSING OF TEKTITE GLASS

Tektite glasses, which must have been located somewhere on or near the surface of the meteoritic planet, have fusing or melting points and general physical characteristics in the form of striae, strain, inhomogeneity, etc., which call for a forming temperature between about 1500 and 2500° C. It should be noted at this point that glasses of this type are not producible as flash products resulting from a collision or short-period heating by other means. Long periods of time are

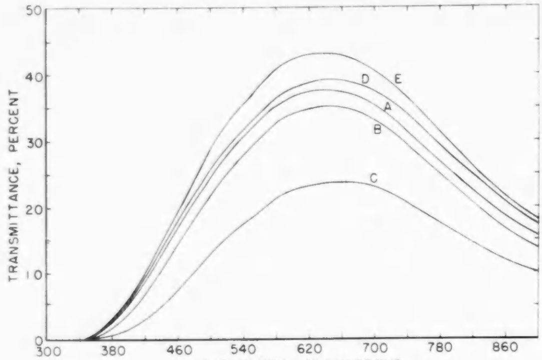

FIG. 2. Spectral transmittances of five australites. Sample A from South Australian Museum; others from H. H. Nininger.

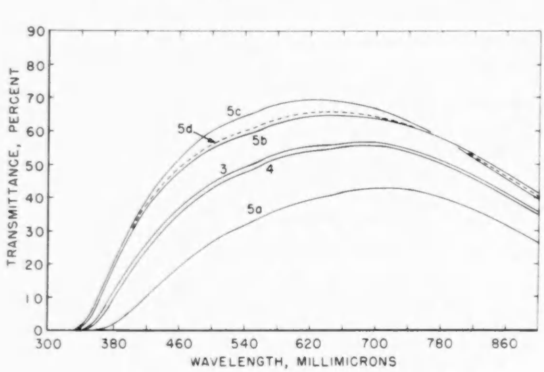

FIG. 3. Spectral transmittances of six bediasites. No. 3 from near Muldoun, Fayette County; No. 4 from eastern portion of Lee County; and *5a*, *5b*, *5c*, and *5d* from near Bedias, Grimes County, Texas. (*Courtesy Virgil E. Barnes, University of Texas.*)

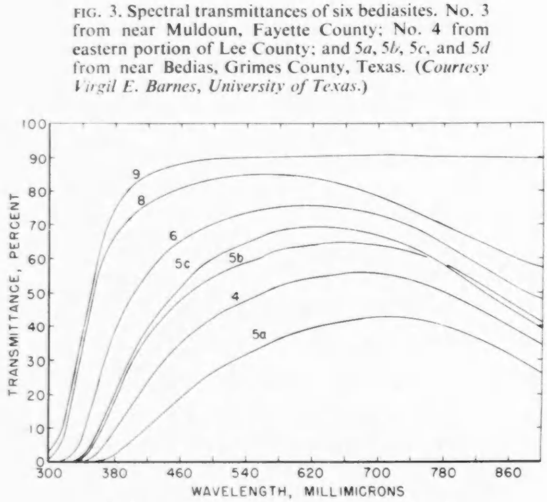

FIG. 4. Spectral transmittances of seven tektites from various sources. No. 9 a Libyan Desert Glass from Egypt; No. 8 a moldavite from Radoivibix, Bohemia; No. 6 from Empire, Georgia; and the others bediasites from Texas (see Fig. 3).

required for the different oxides composing the glass to fuse properly and mix into a more or less homogeneous glass product. During this time the temperature must be well above the melting point of the glass. Temperatures too high, on the other hand, would vaporise certain components of the glass. However, the general character of all the tektite glasses indicates incomplete mixing, as is to be expected under conditions wherein new materials are being constantly added to the glass batch. The fact that certain of the alkalis remain within the glass is an important consideration in any study of the temperature conditions under which the tektites were formed. The presence of oxygen in combination with the various metals forming the basic structure of the glass serves as conclusive evidence of the existence of that element in considerable amount on the meteoritic planet at the time the tektite glasses were formed. Simulated laboratory tests in the making or melting of glasses of similar composition (or, better, with some of the tektite glasses) should result in very useful information regarding the conditions under which they were formed. If the glass were heated to higher and higher temperatures, certain of the oxides would be expected to boil off successively, leaving glass of such composition as to make possible a correlation between the glass compositions and the temperature conditions under which it was made.

THE TEKTITE SPECTRUM

A study of the spectral transmissive properties of thin slices of tektite glass offers a convenient means of obtaining certain information concerning their physical and chemical constitution. Many other avenues of investigation are awaiting exploration. The transmission curves in the ultraviolet, visible, and infrared for some

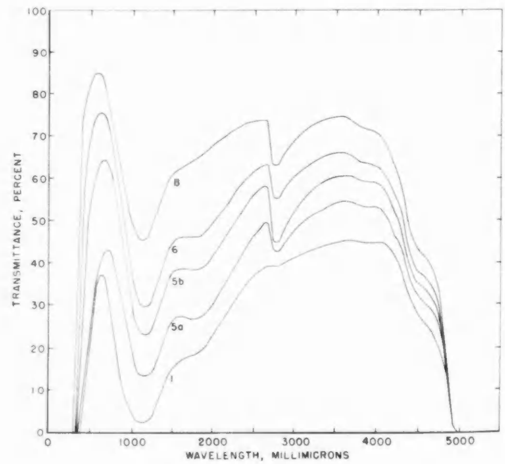

FIG. 5. Spectral infrared transmittances of five tektites from various sources. No. 8 a moldavite; No. 6 a Georgia tektite; Nos. *5a* and *5b*, Texas bediasites; and No. 1 a Philippine rizalite.

of the tektites are given in Figs. 2 to 5. The ultraviolet and visible transmissive properties of a number of australites (shown in Fig. 2) and of a group of bediasites (shown in Fig. 3) illustrate the family character of specimens of this glass picked up at scattered locations in the two cases. The curves of Figs. 4 and 5 illustrate the types of variations in transmissive properties which may be expected between samples from different tektite falls. An examination of these transmission data in relation to the values for chemical composition given in the table is an example of just one method of scientific investigation into the physical and chemical properties of these glasses.

DISRUPTION OF THE METEORITIC PLANET

Now that we have the tektite glasses, as well as the other glassy silicates, together with the other meteoritic material located within a planet (or planets) possibly between Mars and Jupiter—what next? That is a big question. If the tektites were a small part of a large solid body having the general characteristics of a planet similar to the earth—then it must have been broken up for some reason, but how? Not because of an atomic or super bomb made by intelligent beings—there were none. There could have been an atomic explosion—or even a collision with a stray planet from outside the solar system. It is believed, however, the answer is simple and logical, and is to be found elsewhere. Suppose, for example, that two planets existed within this region of the solar system. These planets would have been acted upon by the giant planet Jupiter in such a way that their individual orbits would have been constantly changed relative to each other and to Jupiter. Under such a situation anything might happen—for example, a collision between them would ultimately result, given enough time.

The solar system had its beginning some 4500 million years ago. Presumably the parent bodies of the present meteorites and comets (also tektites) had their origin about this same time. Attempts to measure the age of meteorites and also of tektites (since their separation from the parent body) have been made by a study of various atomic changes within their composition. Not only do the different determinations vary, but studies on different meteorites result in various ages ranging from less than one million to almost 7000 million years. Although some specimens indicate an age approximating that of the universe itself, other data indicate that many meteorites have their origin at a much later date, possibly within the last few hundred million years. Hence, it may be that some 1000 to 4000 million years elapsed between the creation of the universe and the formation of the meteorites resulting from planetary collisions. During this time the planets would have made hundreds of millions of revolutions about the sun and thus would have had an opportunity to suffer great orbital changes even if only slightly perturbed each time the vicinity of Jupiter was approached.

Certain evidence favour the hypothesis that the planetary source of the recovered meteoritic sample was such as to allow their formation at the various levels of temperature and pressure that would be expected in a single planet wherein equilibrium conditions were attained at a single high value at the centre. Other evidence, such as variations in the metallic compositions of recovered iron meteorites, indicates their belonging to not less than two or three distinct groups. Whether this means they originated from the break-up of three or more bodies is problematical. It at least indicates they probably did not result from the break-up of a single body, unless it be assumed the metal became concentrated in several independent locations within that body. In any case the mechanical strength of the various nickel-iron specimens, coupled with their irregular shapes, would indicate that in no case did the metallic meteorites exist as a solid central core in any cosmic body. They must have existed as small metallic concentrations intermingled with much stony material, otherwise they would exist in space only as very large bodies having a more or less spherical shape.

In the case of a planetary collision, depending upon the relative velocity of the two bodies, we might have them smashed and the pieces sent flying off at various speeds in all directions. Some of the material might be expected to become diverted into hyperbolic paths and to leave our solar system for ever. Other fragments, together with possible moons associated with the planets, would continue to circle the sun as meteors, asteroids, and possibly comets, in orbits of various sizes, eccentricities, and inclinations.

Whether the comets, which are known to be composed largely from frozen gaseous materials such as carbon, nitrogen, ammonia, carbon monoxide, and carbon dioxide, were originally part of a colliding planetoid, or were independently formed, is an unanswered question. There is considerable evidence that they are composed of solid fragments more or less held together by the frozen gaseous materials which vaporise and glow with a great brilliance when the comet reaches the vicinity of the sun.

The Meteor Crater in Arizona is a good example of what happens when a meteorite composed of chunks of nickel-iron collides with the earth. The craters on the moon, visible through a small telescope, are a pictorial record of such collisions through the ages on that body. Not all the craters on the moon, however, should be credited to collision with fragments of the lost planet which is responsible for the meteors, comets, and part or all the asteroids now a part of our solar family. Since the age tests on meteorites and tektites indicate that these objects have been subjected to the cosmic-ray intensity in our part of the Milky Way (our galaxy) for a period not exceeding a few hundred million years as indicated above, then only the newer craters—in general the smaller ones—could have been produced by this material. It is suggested that the larger lunar craters, which, incidentally, were made during the early history of its formation nearly 4500 million years ago—must have been made by the impact of very large objects from some other source. A possible and logical source of such objects could have been a family of small moons once circulating around our earth.

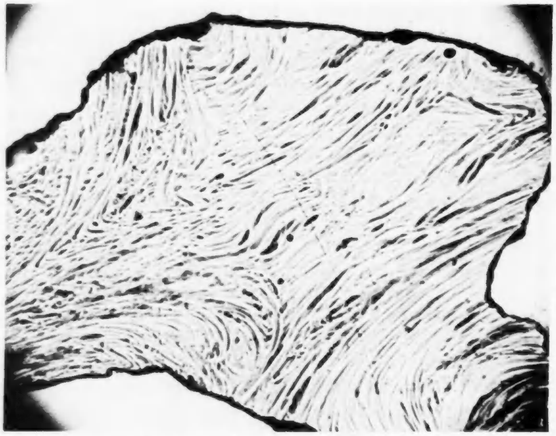

FIG. 6. Moldavite, illustrating the inhomogeneity of a thin polished section by means of transmitted light.

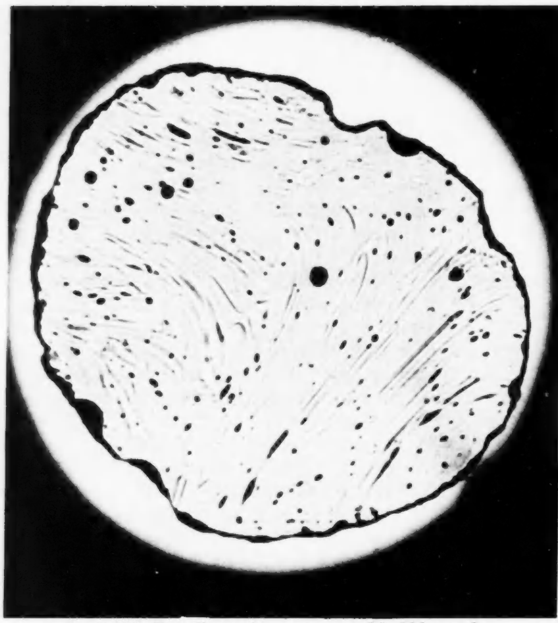

FIG. 7. Rizalite, illustrating presence of bubbles and marked inhomogeneities by means of transmitted light.

FLIGHT OF THE TEKTITES

How do we get the millions of small glass tektites from the debris of the lost meteoritic planet? Why not a few large chunks of glass? Glass is a fragile article, especially when not well annealed. It readily breaks upon mechanical or thermal shock. Take, for example, a chunk of such material travelling at forty to fifty miles per second, the usual speed of many meteors. When it hits the earth's atmosphere an immense amount of heat is developed at its surface. The glass suffers both a terrific thermal and mechanical shock. It necessarily flies apart and is scattered in many small pieces over a wide area, usually elliptical in shape. The sizes of the many small pieces depend upon the coefficient of expansion, the degree of annealing, and other physical properties of the material. Tektites having variations in composition are found to vary in size in general accordance with their physical characteristics. Libyan Desert Glass may be found in pieces up to 10 lb., while a moldavite, having an intermediate coefficient of expansion, may weigh up to a pound or two, but a tektite of relatively high temperature coefficient of expansion, for example an australite or rizalite, is found only in very small pieces usually weighing not more than an ounce or two.

Striae, strain patterns, and inhomogeneities indicate that the small pieces were once a part of a larger body, since there is a lack of any appreciable distortions near the surfaces. Figs. 6 to 9 show this characteristic of a

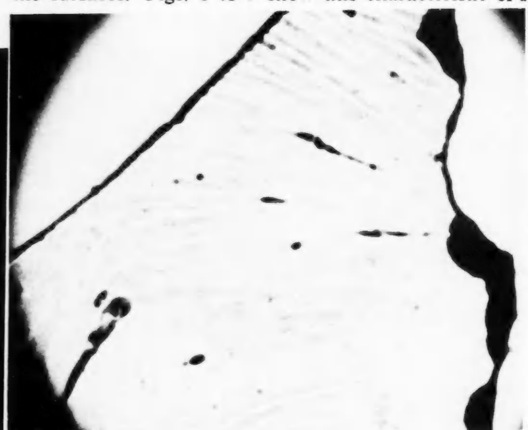

FIG. 8. Georgia tektite, illustrating the inhomogeneity of a thin polished section by means of transmitted light.

FIG. 9. Libyan Desert Glass, showing internal structure of a thin polished section by means of transmitted light.

number of the tektites. This fact rules out the formation of these glass specimens by a fusion of meteoritic material while passing near the sun in their orbit before landing on the earth. The time of flight through the earth's atmosphere is too short for the conduction of sufficient heat to melt or soften the specimen deeper than a surface film which, for the most part, is swept away as it is formed. Only in the case of some of the australites (whose prehistoric fall was geologically recent) does any evidence remain to show the two distinct phases in the formation of the glass specimen; the central core of glass whose structure indicates a more or less annealed condition indicating that the glass cooled slowly, and an outer surface having high strain and other characteristics indicative of having undergone softening at a later stage. All traces of double melting of all the other tektites, which fell during various earlier ages, have long since been eroded away. Additional sculpturing effects, such as smooth lines and grooves, result from the removal of glass in an uneven manner, presumably in part by the particular aerodynamical forces brought into play with the object travelling at such a high velocity, assisted by a more rapid melting of the softer striae within the glass, but later modified greatly by weathering and chemical reactions and resulting in the removal of quantities of glass where the more solvent material or other inhomogeneities occurred. Figs. 10 to 11 illustrate the character of some of these surface features. Some of them are worm-like grooves and navels, often completely interlacing the surface of the specimen. This feature is more pronounced in some of the billitonites (Fig. 10) which have probably been buried in moist soil for a long time. When examined under low-power magnification (about 10×) numerous fine surface lines

FIG. 10. Billitonites from the island of Billiton illustrating the wormlike grooves and navels resulting principally from chemical corrosion through being buried in moist soil for many years. (*Courtesy E. P. Henderson, National Museum.*)

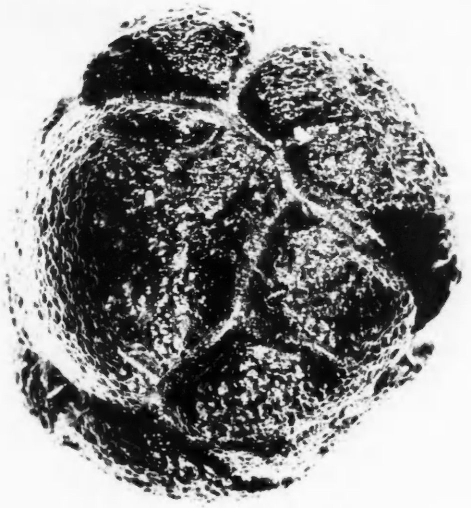

FIG. 11. Tektite from Paracale Bay, Philippines, illustrating surface features often found on tektites recovered within that area. (*Courtesy E. P. Henderson, National Museum.*)

and figures, probably corresponding with the internal striae (Figs. 6 to 9) of the specimen, may be observed both on the outer surface and within the pittings.

TEKTITES, A KEY TO COSMOLOGICAL PROBLEMS

Scientific study of the tektite glasses has been somewhat neglected in meteoritic investigations, principally because it was only recently that their true origin had been established. It was long contended that, as the glass tektites were so far removed from other meteorites in composition, they could not be of the same origin. However, since their durability greatly exceeds that of the softer glasses and their geological associations indicate that they have landed on the earth in showers during the past fifty million years (neither tektites nor other meteorites have been found in any of the ancient geological formations), it appears reasonable to assume that only the more durable types of glass could have survived the weathering of the ages.

The complicated structure of tektite glasses still holds many of the secrets relating to their formation in the parent lost planet. The study of their physical and chemical characteristics together with research in the production of similar glasses should, therefore, furnish valuable information and thus become the key (the Rosetta stone) to the solution of some of the cosmological problems facing the astronomers, geologists, and meteoriticists today by adding not only to our knowledge of the origin of these glassy meteorites but to a better understanding of the formation of the solar system—even of the universe itself.

NEW *GIGANTOPITHECUS* MATERIAL FROM CHINA

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Lecturer in the Institute of Archaeology, London

A recent article* by Dr Pei Wen-Chung, of the Laboratory of Vertebrate Palaeontology of the Academy of Sciences, Peking, refers to several fresh discoveries of human and anthropoid fossils made in Kwangsi Province and elsewhere.

Working in Java before the Second World War, Prof. G. H. R. von Koenigswald, now of Utrecht, found three enormous fossil teeth of what appeared to be a great ape in the stock of a Chinese druggist, where, along with numerous other fossils, they were for sale as "dragon's teeth", an article highly esteemed in the traditional Chinese pharmacopoeia. Names by their discoverer *Gigantopithecus*, though some authorities regard them rather as human, and would prefer the name *Gigantanthropus*, these specimens have for years remained unique, owing to the inaccessibility for European workers of their place of origin in South China. Their exact provenance, however, was never known, though deposits of the limestone caves of Kwangsi were regarded as the most probable source.

Following a country-wide campaign of education among the peasants, vast quantities of fossil remains ("several thousand pounds") were collected from the Kwangsi caves by the local inhabitants and sold to a central organisation at Nanning. Early this year, these were examined by an expedition from Peking under the leadership of Dr Pei. The collection included numerous bones of *Ailuropoda*, the giant panda; *Stegodon*, a primitive elephant; *Megatapirus*, a giant tapir; pig; deer; and many teeth of orang. In addition there were recognised seven new (and even larger!) *Gigantopithecus* teeth and "scores of smaller teeth of an ape-like man". Canton Province later yielded thirty more teeth of *Gigantopithecus* in its collection.

For three months the expedition carried out exploratory work in 300 Kwangsi caves and in Tahsin county three *Gigantopithecus* teeth were eventually found *in situ* in red loam below a fossiliferous breccia attributed to the Middle Pleistocene, 400,000–600,000 years old.

A Late Palaeolithic (200,000 years old) skull from Holung, and a *Homo sapiens* of Neolithic age (10,000–7000 B.C.) also in Kwangsi, associated with an industry and a fauna, still do not complete the list, for an editorial note in a "box" on the same page refers to three other, presumably early, *H. sapiens* finds made since 1949—Tzeyang (Szechuan), Anhwei and Ting (Shansi). No other details are available as yet. China is, indeed, rich!

Some comment is called for on the subject of the dates quoted. Since the International Geological Congress in 1948, the Pleistocene includes the Villafranchian (formerly assigned to the Pliocene) and thereby becomes a period perhaps three times as long as before. Thus, "Middle Pleistocene" today is identical with what we should have called "Lower Pleistocene" before, and corresponds roughly with the period of the *Pithecanthropus* (including *Sinanthropus*) group of fossils.

In Europe, the Palaeolithic stage of culture extends down to somewhere between 20,000 and 10,000 years ago. A skull 200,000 years old, comparable in age with that of Swanscombe, would here be called Lower (or at the very most Early Middle) Palaeolithic.

Our Neolithic (with pottery) begins not before 2500 B.C., even in eastern Europe, though it goes back beyond 4000 B.C. in the Near East and (without pottery) even further, as at Jericho. If there is a true Neolithic in China as early as 10,000–7000 B.C., it will necessitate a complete revision of our ideas about the time and place of the origins of civilisation. Before doing so we must have an opportunity to examine the evidence on which that dating is based.

It is not mere carping to observe that, of forty known *Gigantopithecus* teeth, only three have so far been found in their stratigraphical and environmental context. Of "scores" belonging to a smaller ape-like man not yet one is so recorded. Rich as she may be in Primate and other fossils, one shrinks from imagining the useless pillage of China's irreplaceable cave-deposits represented by these figures and by the "several thousand pounds" of fossil material ripped out regardless of stratification. And this is but one province!

It is some relief to learn from Dr Pei's account that the educational programme referred to now includes steps "to discourage them [the peasants] from moving such finds from the place of discovery". It would have been well to have thought of this at the outset of the educational campaign, instead of seven years after the looting began. Chinese palaeontology would have been the richer for it, not to speak of the rest of the interested world, which shares our common heritage from the past.

We look forward eagerly to more detailed publication of the new finds, which are intrinsically useful from the morphological point of view even when their stratigraphical positions are not known. For such a mass of material a proper morphological study alone will evidently take some years. In the meantime, greater credit will accrue to all concerned if excavation proceeds at a more moderate pace, and only under direct skilled supervision. Neither palaeontological learning nor national prestige is measured in tons of fossils, but in the quality of the work and in the degree by which our knowledge is advanced. The other way is mere vandalism. So far we are but little wiser than before.

* Pei Wen-Chung, 1956, "New Material on Man's Origins", *China Reconstructs*, vol. 5 (8), pp. 9–10.

SCIENCE AND THE SUEZ CANAL

J. H. M. SYKES, Assoc.I.E.E.

It has been commonly said, in recent months particularly, that the Suez Canal is "one of the engineering wonders of the world". In the writer's view, this is only partially true. If, nowadays, some eccentric millionaire were to set thirty thousand men to work, equipped only with spades, to dig a large ditch a hundred miles long in country which did not offer any particular difficulties from the geological point of view, we should certainly regard the achievement with wonder; but our wonder would be directed more at the magnitude of the effort and the result, than at the engineering ingenuity of the project.

In speaking of engineering "wonders", one is bound to allow one's mind to make comparisons between the project in view and others such as the Boulder Dam, the Donzere-Mondragon locks, the Rhine-Main-Danube canal, the Panama Canal with its locks (and landslides), the Simplon Tunnel, and other great engineering achievements where the greatest degree of scientific skill (in relation to the time of the project concerned) had to be brought into play to conquer the unknown difficulties which lay ahead of those responsible.

With that thought in mind, it is nevertheless true to say that the cutting of the Suez Canal, between 1859 and 1869 was a gigantic achievement.

PROBLEMS OF CONSTRUCTION

The first problem which its sponsors had to solve was the possible inundation of practically the whole of Egypt by the waters of the Red Sea, since almost until construction work actually started it was assumed that the Red Sea level was 33 feet above that of the Mediterranean. This meant that locks would be necessary, and as ships would continue to grow in size, locks would never have been adequate for long. Once this error had been corrected by more accurate surveying, it became possible to begin work on a straightforward canal joining the two seas, without any sort of water control works.

In 1854 a French engineer, M. Ferdinand de Lesseps, obtained a concession for creating a maritime canal. He believed that a canal could be cut, and could be successfully operated: but there was considerable opposition. It was said that the canal would become a stagnant ditch, and that it would become filled up very rapidly by the sands of the desert; that the Bitter Lakes through which the Canal route passes would be filled up with salt. Experienced mariners (still thinking very largely in terms of manoeuvring sailing ships) said that navigation of the Canal and its approaches would be dangerous and difficult.

A British soldier, sent out by the Government in London to report on the proposed project, took a more optimistic view. General Chesney, R.A., said, in 1830, ". . . As to the executive part [of cutting a canal on M. de Lesseps' scheme] there is but one opinion; there are no serious difficulties; not a single mountain intervenes, scarcely what deserves to be called a hillock; and in a country where labour can be had without limit, and at a rate infinitely below that of any other part of the world, the expense would be a moderate one for a single nation, and scarcely worth while dividing among the great Kingdoms of Europe, who would all be benefited by the measure."

In spite of General Chesney's opinion, M. de Lesseps, in forming the Suez Canal Company "wishing to stress the universal character of the Company from the very moment subscriptions to the capital were opened, set aside blocks of shares for each of the nations interested in the success of the enterprise. His call was answered by applicants from fourteen different countries, among which France took by far the leading place", in the words of the Company's official description of the Canal and its history.

THE ORIGINAL PROJECT

The original project envisaged a canal roughly 88 miles long, with a width of 190 feet 3 inches at the surface and 72 feet 2 inches at the bottom, with a depth of 26 feet 3 inches. It included 66 miles of actual canal, formed by cutting, and 14 miles made up of dredging through the lakes through which the Canal passes; 8 miles needed no engineering work at all, the depth of the lake water being sufficient.

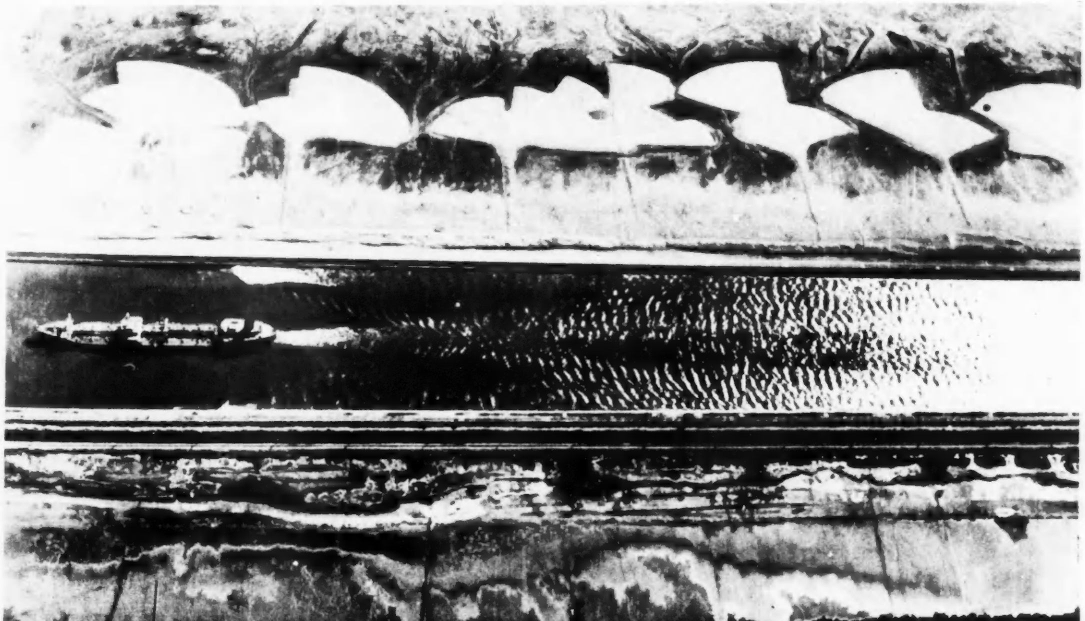
The total excavation needed was 97 million cubic yards. To start with, "picks and baskets", as the official history describes the hand tools used, were employed, with forced labour providing up to 30,000 people.

In 1862 the withdrawal of forced labour by the then Khedive of Egypt, Ismail, meant that Europe had to be scoured for mechanical equipment to carry on the excavating work. It was found that dredging was cheaper than excavating dry material, so that many parts of the project were flooded from the "sweet water" canal which had been built to bring in Nile water for the use of the labour force; up to sixty dredgers were later in use at one time.

The *Illustrated London News* of April 3, 1869, carried the following description of the dredging work on the Canal: "There were several steam-dredges afloat upon the water, attended by flat-bottomed oblong punts, each of which receives from the dredges a number of open boxes of caissons, filled with the earth or mud that has been raised from the bottom, and then conveys them to the 'elevator', a machine erected on the bank of the Canal, by which they are severally lifted out and run up along the tramway of a sloping platform to empty themselves 60 feet or 70 feet away from the water's edge. There is a different kind of mechanical apparatus, called the *drague à long couloir,* which is used in immediate connection with the dredging-vessels, where the banks are not so high above the water. . . . The dredges are furnished with iron buckets fastened to an endless chain revolving over two drums; one being fixed at the end

FIG. 1. Aerial view of the bypass in the present Canal.

FIG. 2. Aerial view showing the damp mud fanned out from the dredges on one side of the Canal. Note on the other side a series of parallel lines, which are a road, a railway line, and a sweet-water canal to supply the stations alongside the canal. (*The two photographs on this page by courtesy of the Suez Canal Company.*)



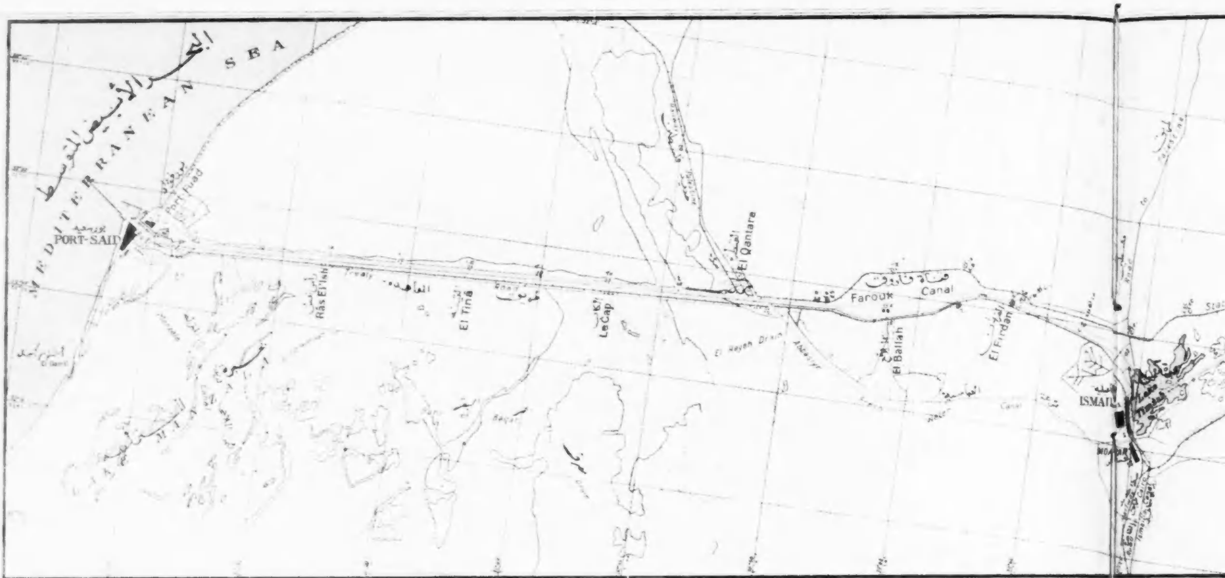


FIG. 3. General map of the Suez Canal today, scale 1 : 250,000. Th thickest line sho are in double dotted lines. Secondary roads and tracks shown by single dotted l

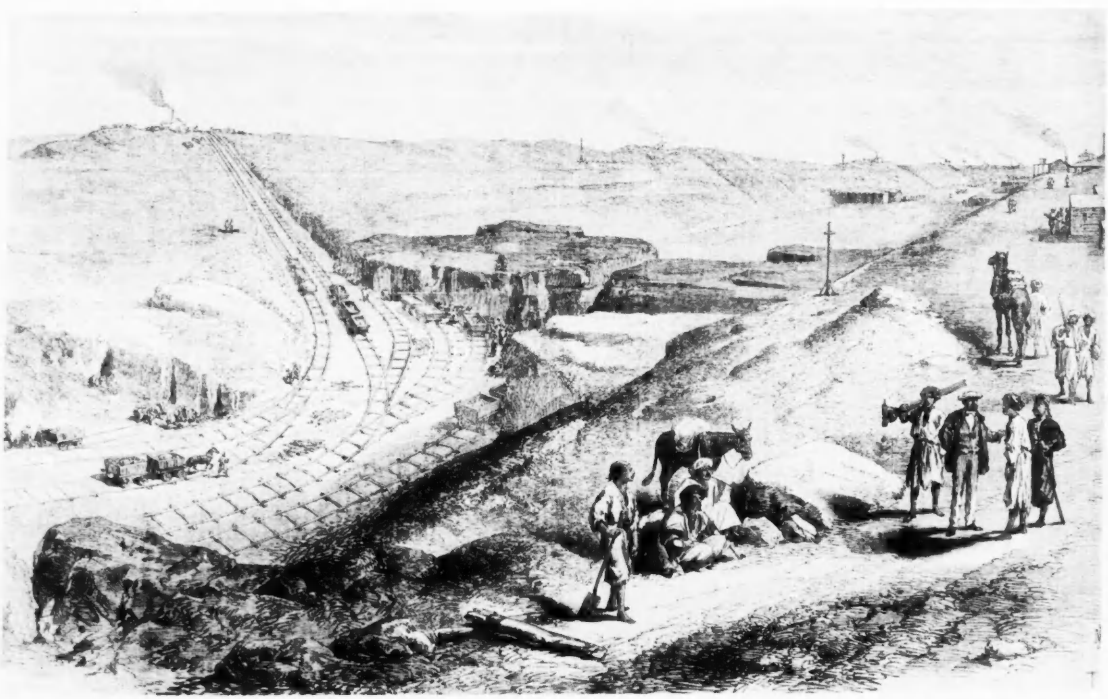


FIG. 4. The isthmus of the maritime canal showing the cutting near Shalufa as it appeared in 1869. This print is taken from the *Illustrated London News* of that year.

FIG. 5
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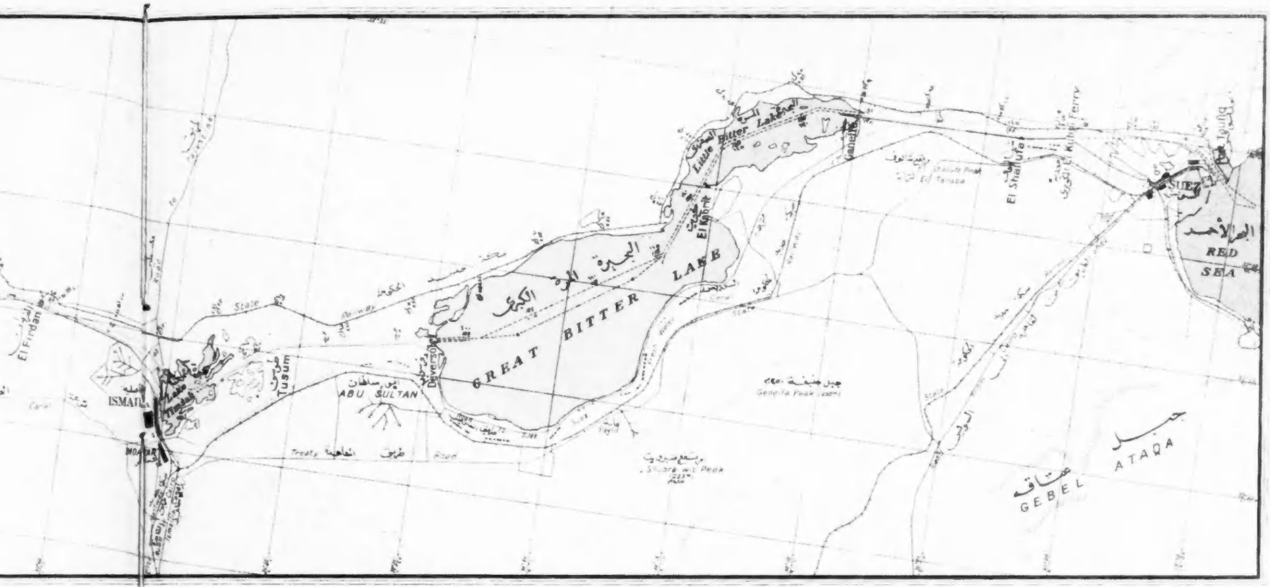

scale 1 : 250,000. The thickest line shows the maritime canal, and main canals and drains and tracks shown by single dotted lines. The shaded area is land under cultivation.

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FIG. 5. The isthmus of Suez maritime canal near El Qantara in 1869, as shown in the *Illustrated London News* of that year, showing a dredge at work in the water, the flat-bottomed oblong punts, and the elevators on the banks.

of a long movable arm, regulated by the depth at which the mud is scooped up; the other being at the top of a strong iron framework mounted upon the hull of the dredging vessel. They vary in size and power, the smallest being of 15 horse-power and the largest of 75 horse-power. The boxes, or caissons, have each a capacity of four cubic yards, and seven of them fit into one of the attendant punts. . . . The long couloir, or long duct, is of curved or half-elliptical form, sometimes 75 yards long, but often smaller, with a slightly inclined channel 5 feet wide and 2 feet deep, which is supported by an iron framework on the deck of a barge; a steam pump keeps a stream of water flowing through this channel, by which the dredged-up matter, when dropped into its upper end, is carried off and cast ashore on the bank of the canal; this process being aided in some cases by the action of the *balayeur*, an endless chain passing along the centre of the channel and bearing a number of iron scrapers to remove the half-liquid slime and mud." *(See Figs. 4 and 5.)*

IMPROVEMENTS

The Canal Company began a lengthy series of improvement programmes from the very start of commercial operation of the Canal, and these have been directed to widening and deepening, and the provision for more "sidings", so that large ships could pass each other without difficulty. The improvement programmes have necessitated the excavation and dredging of no less than 200,500,000 cubic yards of material. The banks have been lined with a stone bedding revetment.

The latest improvement programme allows for the passage of ships with a draught of 36 feet, compared with a total water depth of 26 feet 3 inches at the time the *Aigle*, draught 15 feet, which carried the Empress Eugénie along the Canal on the opening day, November 20, 1869.

AN ALTERNATIVE TO THE CANAL

The present political difficulties surrounding the operation and ownership of the Canal naturally give rise to speculations as to the possible alternatives if the Canal, for one reason or another, cannot be used by the ships which at present pass through in daily convoys.

The shipping using the Canal has steadily grown, in annual total tonnage, from 436,609 tons in 1870 to approximately 91 million tons in 1955. The enormous rise in world oil consumption, and the very large deposits of oil found in Middle East oilfields, has meant that the Canal traffic has become increasingly concerned with oil transportation. In 1955, 67 million tons of oil came through the Canal (care must be taken not to apply too close a comparison between the dead-weight of the oil transported and the shipping tonnage measurement figure, of 91 million tons in 1955, mentioned earlier: but the figures enable broad conclusions to be drawn).

While all or any of the merchandise carried through the Canal could possibly be carried round the Cape, this would mean an extra passage of about 5000 miles. For an average cargo steamer, this would mean about

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Map showing alternative canal and possible railway to by-pass present Suez Canal.

twenty-one days' extra sailing, depending on its ports of origin and destination. For example, a ship making four round voyages a year, thus involving a total of eight passages through the Canal, could only make three trips if she had to sail round the Cape instead. Thus four ships would be needed for every three now employed to carry the same total tonnage of merchandise in a twelve-month period. The only alternative here is faster ships: but faster ships cost more to build and more to operate, and larger ships cannot always be accommodated at the ports used by ships now regularly passing through the Canal. A quotation from a contribution to the discussion of "Mechanical Engineering in the Mercantile Marine", by T. A. Crowe, M.Sc., M.I.Mech.E., presented to the Joint Engineering Conference, 1951, illustrates the position in regard to the cost of delaying ships during service: Mr J. Lamb said: "The cost of operating oil tankers has more than trebled during the previous fifteen years, and for a ship of medium size—say, 18,000 tons dead-weight—the loss in earning capacity for each day's delay in port is more than sufficient to purchase 100 tons of liquid fuel in London. With a 28,000-ton dead-weight tanker, the cost was almost four figures a day."

Thus, while it would obviously be feasible to carry all the present traffic through the Canal by way of the Cape, the capital cost of providing the additional tonnage would be very great, and the delay in which any particular consignment would be involved might also cause severe commercial difficulties.

Are there any ways in which science could help to solve the problem which might be posed by the non-availability of the Suez Canal?

To transport the vast tonnage of goods, including oil, now carried by the Canal, there can, in effect, only be one economically feasible alternative to the present Canal: another one, on a site not subject to the same political problems. But for one particular commodity, oil, pipelines could possibly be substituted. At present 40 million tons of oil, out of the total of 145 million tons of oil exported from the Middle East, flow through pipelines to the Mediterranean.

For the cutting of a second canal, outside Egyptian territory, it would be necessary to go eastwards as far as the Israel boundary. The second canal might possibly run from the head of the Gulf of Aqaba to the Mediterranean, and would need to be about 140 miles long. The level of the land on the boundary path rises to over 1000 feet, and thus a much greater excavation volume would be necessary. Rough calculations made on a profile of this route show that in addition to the amount of excavation needed for the canal itself (taken at 456 million cubic yards, a proportionate increase for the 140-mile length, compared to the total excavation of 297,500,000 cubic yards for the present Canal and its improvements), there would be an extra 150 million cubic yards to excavate, for a sea-level canal without locks on the new route with its higher ground. Thus the total excavation would be of the order of 606 million cubic yards.

Recent figures for earth-moving work carried out on the Donzere-Mondragon hydro-power and canal scheme on the Rhône, involving much the same type of dredging and excavating work and concerned with a project where the very latest types of scientifically designed and controlled earth-moving machinery were employed, show that a maximum figure of 380,000 cubic yards of excavation a week could be achieved. With equipment consisting of five bucket dredgers and five draglines, all of the largest sizes, as used at Donzere-Mondragon, the second canal project would thus take thirty years to complete. By quadrupling this plant, and so assembling perhaps the greatest conglomeration of earth-moving machinery ever gathered together on the earth's surface, the new canal could perhaps be built in about eight years, two years less than M. de Lesseps needed, using only hand labour for part of the time.

It is impossible to make any realistic estimate of the cost: but a project in which 65,500,000 cubic yards of earth had to be excavated cost £54 million in 1954, and would probably cost £62 million at the present time: and this very rough estimate is only for the earth work, and excludes the port installations and the dredging of the Gulf of Aqaba. The total cost would probably reach nearly £100 million.

Measured by the scale of great national and international projects for the control of waterways such as the Kariba Gorge scheme, the Tennessee Valley Authority's overall plans, the St Lawrence River scheme, the Turkman Canal and a few other comparable schemes, this sum, spread over eight years, is not a figure which renders the project totally unacceptable.

Science might well be able to assist in shortening the time needed for such a canal by providing blasting forces of a modified atom-bomb nature. It might be economic to bore deep shafts into the rock and explode a series of atom bombs, waiting as long even as two or three years to allow the harmful radiations attendant on such explosions to disperse before wholesale removal of the spoil was begun.

Scientific assistance in surveying work could be rendered to the builders of the new canal. Aerial photography would provide maps from which to set out the route: geophysical surveying methods would ensure that the builders had exact knowledge of the nature of the subsoil. Automatic electrical control equipment could co-ordinate the operation of the dredgers and draglines so that the spoil was always removed at a rate co-ordinated with the rate of excavation, probably using variable-speed conveyor belts: and this would be a considerable help, since the use of large quantities of trucks, running on unmade roads, for spoil disposal—the method frequently adopted in the past—leads to waste of manpower and hold-ups due to the need to repair the heavily worn road surfaces at frequent intervals.

New concrete mixing and distributing methods, with automatically controlled batching of the cement, aggregate, sand, and water, and pneumatic and hydraulic pumping of the mixture right to the point of application, would help to speed up and cheapen the work of lining the banks, and would greatly reduce the labour force.

Closely co-ordinated short-wave radio links would enable one of the major problems on a vast construction site—that of communications between the many working sites—to be solved in a much better manner than has been possible hitherto.

The earth-moving machinery would benefit from recent metallurgical work: harder steels for the jaws of excavating grabs enable longer life between replacements, and fewer hold-ups due to broken equipment.

ALTERNATIVE OF A PIPELINE

Turning now to the other alternative to the present Suez Canal, pipelines could be built spanning the distance of between 500 and 1000 miles between the oil-producing areas, such as Kuwait, and the Mediterranean ports of Israel, the Lebanon, and Syria. Scientific development has recently helped pipeline operations in two ways. The necessary pumping stations have been equipped with efficient gas turbines, sometimes using the natural gas which is often available in oil areas, and sometimes tapping oil from the pipeline itself. These machines have the advantage that they do not require cooling water, and in desert areas the provision of the necessary water can be a serious problem. Moreover they will operate on almost any kind of fuel, so that the degree of refining carried out at the oilfield has no effect on performance and there is no need to install a network of supply tankers or additional pipelines for fuel supplies to the pumping plants.

The operation of a long pipeline presents special problems of communication. The steadily increasing range of facilities offered by ultra-short-wave equipment, with frequency-modulated transmission, means

that the control of pumping pressures and the operation of the pipeline can be made much easier and more reliable.

In the actual construction of the pipeline, modern welding equipment can offer not only great savings in time but also greater security against leakage. It is possible, by using radioactive isotopes, to check each welded joint as it is made, so that later leakage is prevented. The injection of radioactive isotopes into the oil itself can enable hidden leakage in buried pipes to be detected. The use of electronically controlled cathodic protection can prevent corrosion from attacking the pipes in areas where the chemical qualities of the soil may cause trouble.

Thus science can help in the laying and operation of pipelines, and it is conceivable that all the oil traffic in the present Canal could be carried by additional pipelines.

In several countries there have been recent experiments in carrying coal through pipelines, using pumped water as a transporting medium: and grain is sucked and pumped through pipes in unloading and storage operations at most large ports. It is therefore possible that some other products carried at present by ship through the Canal might be pumped through new pipelines laid outside the politically difficult territory. But there would still remain the cargoes of textiles, metal goods, heavy equipment such as power-station plant, railway locomotives, paper and wood pulp, and the vast mass of miscellaneous commercial products.

OTHER ALTERNATIVES

There are two other alternatives which it is worth while mentioning. From the Red Sea to the Mediterranean via Saudi Arabia, Jordan, and Israel is about 280 miles, and some sort of railway might conceivably be laid across this distance. It might well be of a novel type, using a very broad gauge, so that bulky items of merchandise, such as excavators, the rotors and stators of electrical machinery, and the like, could be carried: and such a railway might use very large trucks, say of 100 tons capacity each, which would facilitate rapid transfer of the whole of a ship's cargo from a new deep-water port in the Red Sea to the Mediterranean port, where again transfer to ships would be made easier than with the normal 10- to 20-ton waggons usually employed. With such a railway there might be combined a high-speed monorail, running suspended from a rail above the track, for light goods and passengers.

Another possibility is an air lift. The notable achievement of the Berlin Airlift during the blockade of that city some years ago proves that even coal for power-station boilers can be transported by air, in quantities of the order of hundreds of tons a day: but the cost, for normal commercial service for goods which in many cases would have to compete in the export market at the end of their journey with goods from other countries where normal sea transport was still available, would be entirely prohibitive.

The possibility of a tunnel under the isthmus is not ruled out technically, but the cost would be fabulous, and its dimensions, for railway traffic commensurate with the present sea traffic through the Canal, would be greater than those of any tunnel yet conceived. It might just be recalled that Captain Nemo of Jules Verne's *Nautilus* found a natural under-water tunnel connecting the Red Sea and the Mediterranean.

CONCLUSION

We are thus left, after this survey of what science could do to help in providing a full alternative to the present Suez Canal, only with a second canal, longer than the first and running through more difficult country. Political considerations are outside the scope of these notes, but there might still remain, even after a second canal was built, the same problems of control and operation which have caused the recent crisis to emerge. Here, science—so far—has been unable to be of assistance: political forces do not respond to the analytical methods of the scientist, and human emotions cannot be controlled by laboratory methods.

TWENTY-FIVE YEARS AGO

From DISCOVERY, 1931, October, Volume XII, p. 324

An Airport for Central London?

The following are extracts from an article by C. W. Glover, L.R.I.B.A., designer of a suggested airport for central London:

"It is evident that an aerodrome situated outside a town does not properly effect the desired interchange facilities, and is often an inconvenient distance from the railway terminus. A ground aerodrome established in the heart of a city must necessarily be extensive. . . . On the other hand, the elevated aerodrome clear of all obstructions can be kept down to the minimum area. . . . In large cities in which considerable air activity is to be expected, elevated airports of the wheel type are advisable, for considerable parking space is provided at the landing level on the peripheral taxiways, through which would pass the lifts to the hangars established in the supporting buildings. The scheme for London is estimated to cost five million pounds, but the development is sectionalised, each portion being separately justified and self-supporting. . . .

"But speed in the air is of little use without corresponding speed and comfort on the ground. The aeroplanes set a standard which the aerodrome must rival. It is in large measure true to say that the future of aviation now rests on the ground."

In this unfulfilled plan for the future, two important factors seem to have been unforeseen: the ever-increasing landing space required as the speed of aeroplanes grows higher; and the nuisance caused by the noise from an airport placed within a built-up area.

SCIENCE VERSUS SENESCENCE

DONALD MICHIE

Royal Veterinary College, University of London

Dr D. Michie took his doctorate in genetics at Oxford University in 1952. Since then he has been working on problems of mammalian genetics and reproductive physiology, with particular emphasis on the rôle of the prenatal environment in heredity and development.

At the turn of the century the expectation of life for a baby born in the United Kingdom was fifty years. Today it is sixty-eight for men and seventy for women. One consequence is that at present one out of every seven people in Britain is of pensionable age, and in twenty-five years' time the proportion will be one in five.

Yet the prospects of further survival for this elderly fraction of the population have been little improved during this same period. In 1901–10 a man aged sixty in the United Kingdom could expect to live a further $13\frac{1}{2}$ years. Today his expectation is just over $16\frac{1}{2}$ years. In other words, medical and social advance in the past half-century has largely solved the problem of keeping us alive until we are old—to a great extent through reducing infant mortality—but has so far proved almost powerless to retard the deteriorative changes collectively known as "senescence" which, if nothing else does first, will eventually kill us.

These figures are taken from a stimulating review of "Medical and Social Problems of Aging" by Prof. R. E. Tunbridge (see bibliography). They go some way to explain the growing interest which the scientific study of ageing is attracting. To the biologist the problem of senile decay is especially provoking; for he cannot see any clear reason why a self-repairing system like himself, or the animals which he studies, *should* deteriorate with the passage of time.

THE SENESCENCE OF MOTOR CARS

As it grows older a motor car becomes less efficient, more prone to damaging mishaps and more likely to be irretrievably damaged by any given mishap. But we know that this is due to the deterioration, under repeated stress, of its individual parts. On the other hand many of the individual parts of a living organism can survive and function indefinitely in an artificial medium, as was first demonstrated when Alexis Carrel kept the isolated heart of a chicken beating for twenty-five years. Nobody, in fact, has yet demonstrated the occurrence of senescence *in vitro*.

Yet the analogy of the motor car is useful in that it focuses our attention on the point at which the analogy breaks down: on the connexion between senescence on the one hand and, on the other, the processes of anabolism and cellular proliferation which are features not only of self-repair and regeneration but also of growth and development.

In his recent comprehensive survey, "The Biology of Senescence", Dr Alex Comfort rightly stresses the importance of the few experimental attempts which have been made to explore this connexion. It is worth quoting at some length Comfort's account of McCay's (1952) classical experiment with rats:

> Groups of rats were reared on a diet sufficient in all other constituents but deficient in calories, and their growth thereby retarded. After periods of retardation up to 1000 days, the calorie intake was raised to permit growth. The animals then grew rapidly to adult size, even though the longest-retarded group had already exceeded the normal life span for the strain, and continued to live to approximately twice the maximum age reached by unretarded controls. This long survival was accompanied by a decreased incidence of many chronic diseases, which appeared to represent a true diminution in senile liability to death from random causes. The chief specific diminution was in death-rate from pulmonary diseases and from tumours. "In general, the retarded rat remains active and appears young whatever its chronological age. It is very alert. It tends to go blind in the second and third year of life. Its pulse rate of 340 beats per minute is about 100 below normal."

It was not possible to prolong the life of the rats indefinitely, for if the period of food restriction was extended much beyond 1000 days, they became incapable of resuming growth when put on full rations. The dietary restriction acted specifically through the postponement of the age at which adult size was attained. This is evident from the effect of starving *adult* rats. Some prolongation of life occurred, but it was small compared with that obtained by starving young rats, and probably belongs to the same category as the lower life expectancy of fat people as compared with thin, or, for that matter, of smokers as compared with non-smokers: important from the point of view of staying alive, but irrelevant to the general problem of senescence.

SENESCENCE AS A MORPHOGENETIC PROCESS

In discussing McCay's experiment, Comfort suggests that senescence may represent a developmental process which, in common with developmental stages at the other end of life, is not set in motion until the sequence of stages leading up to it has been completed.

It is perhaps possible to view in this light Sonneborn's elegant experiment on the flatworm *Stenostomum*, published in 1930. He showed that the rejuvenation conferred by asexual reproduction was unequal for the two products of fission. Lines propagated by keeping the

head portions, which only needed to regenerate tails, died out after a few divisions. The tail portions, from which almost the entire body and nervous system had to be regenerated, could be propagated indefinitely. One might say that in regenerating a head portion the organism is taken back to the starting point of the morphogenetic process. If it is restarted at each asexual generation it never has the opportunity of completing its developmental programme and reaching senescence.

In very recent unpublished work (in press) Sonneborn has found the key to the hitherto mysterious "clonal ageing" of the one-celled ciliate, *Paramecium*. This creature can reproduce sexually, either with another *Paramecium* (conjugation) or with itself (autogamy). It can also reproduce by simple binary fission, and the aggregate of individuals stemming by this process from a single ancestor is called a clone. As the clone passes through many fissions it becomes progressively enfeebled, the death rate among its individual members mounts increasingly, and it eventually becomes extinct. It can, however, be rescued, provided that things are not allowed to go too far. A single sexual generation (either conjugation or autogamy) is sufficient to restore its lost vigour.

Paramecium is peculiar in having two nuclei, a micronucleus which carries the hereditary properties through the sexual process, and a macronucleus which gives effect to them by supervising the vegetative activities of the cell. The two kinds of nuclei fit neatly enough into Weismann's categories "germ-plasm" and "soma". In asexual fission the micronucleus and the macronucleus both divide and the products of their division are apportioned to the two daughter cells. But sexual reproduction terminates the existence of the mortal "soma", and each daughter cell is fitted out with a new macronucleus by the activity of its micronucleus.

Sonneborn's discovery was that in asexual fission the macronucleus, in which each chromosome is represented many times, distributes its chromosomes at random to the daughter macronuclei. As the process is repeated there is an increasing chance that daughter cells will arise in which one or more chromosomes are not represented at all. The number of cells with unbalanced macronuclei steadily mounts, and the deterioration cannot be halted unless a sexual generation is interposed: the old macronucleus is then scrapped and a new one is created in the image of the unimpaired micronucleus.

It is tempting to seek in this some kind of model for the senescence of many-celled organisms. Dr Comfort is sternly discouraging of such speculation, apart from a tantalising reference to "the light which it might possibly throw upon the effects of cell division in renewing expendable enzyme systems". He does at the same time mention a further discovery of Sonneborn's which cannot but inflame the geneticist's imagination and which may have application to higher organisms. If clonal senescence is permitted to go too far the rescue operation of autogamy fails, because the micronucleus itself has been permanently affected by its coexistence with the defective macronucleus.

ROTIFERS, STRAWBERRIES, AND DR WEISMANN

This result stands Weismann on his head, for here the ephemeral soma has moulded the supposedly aloof and impervious germ-plasm. It also finds an echo in the recent finding in higher organisms that the characters of the offspring can be affected by the age of the parents. Lansing found that the offspring of ageing rotifers died young. McWhirter (1955) has recently shown that senescent clones of strawberries can transmit their enfeeblement through the sex cells.

In considering the opposite process, that is, the effect of the genetic constitution upon senescence, Comfort makes a suggestion which will seem equally strange to geneticists of an orthodox turn of mind. Distant crossing in habitually outbreeding species commonly results in "hybrid vigour", which manifests itself, *inter alia*, in faster rates of growth and development, greater resistance to disease and to climatic and other stress, and higher fertility and fecundity, as compared with the parental forms. The widespread use in Central Asia of hybrids between the one-humped and the two-humped camel comes to my mind as one example of the practical exploitation of this phenomenon. "Hybrid vigour", at least in some cases, is accompanied by a striking postponement of senescence. The life table of Clarke and Maynard Smith's inbred fruit flies enters the steep part of the curve after only ten days, while that of their first-generation hybrid flies does not begin to plunge until after fifty days. Gates' hybrids between an Asiatic and a European subspecies of mouse were still breeding well at the age of two years. The corresponding figure in my own laboratory for ordinary crossbred European mice is about one year, and for inbreds about six months.

Is there, Comfort inquires, any means of conferring something of this phenomenon upon an individual organism other than by judicious choice of its parents? Is "the induction of vigour by non-genic means" a possibility?

We do not know how or why hybrid vigour works. But it is widely surmised that added versatility conferred by possession of two *dissimilar* biochemical endowments from the two parents is part of the story. Guided by this thought a number of attempts have been made to enrich the endowment of one organism by non-sexual union with another of contrasting genotype. Embryonic parabiosis and exchange of egg-constituents in birds, egg-transfer in mammals, ovarian grafts, and, in plants, graftings of various sorts are among the methods which have been employed, chiefly by adherents of the Michurinist school. It is a pity that in reviewing some of this work Comfort overlooked the earliest, and I think one of the most convincing, of such studies. In 1931 the Japanese worker Umeya reported that silkworms bred from ovaries which had been grafted into females of another strain showed all the earmarks of

hybrid vigour. He did not, unfortunately, study their longevity.

THE "PRIMITIVE EXPERIMENT"

In view of such work, I was surprised when reading Comfort's book to find that no one apparently has yet done in gerontology what I term the Primitive Experiment. The Primitive Experiment is applicable to almost any branch of biology. It was, I suppose, first done by the first man to drink the blood of a sabre-toothed tiger in the hope that he might derive from it some of the animal's strength and courage. The reasoning is clear. We wish to transfer a certain quality from X to Y. The quality quite probably resides in some specific substance in X, and hence may be transferable to Y by simple transfer of the substance.

The Primitive Experiment, in addition to resounding failures, has many spectacular successes to its credit. It laid the foundation of modern bacteriology and virology; in immunology the protection of an infected animal or human patient by the transfusion of serum from an individual convalescent from the same disease is based upon it; the transfer of cancers in fowls and cotton-tail rabbits by cell-free extracts, and in mice by suckling upon a cancer-susceptible foster-mother, and the discovery and investigation of hormones in animals and plants are further reminders that we should pause before dismissing too lightly this crude method of attack.

In a sense Voronoff's attempts at rejuvenation by gonadal grafts represented an ill-starred foray into this field. But the simple and obvious application of primitivism in gerontology is the injection or grafting of young material into old bodies, with the necessary immunological precautions which were not understood in Voronoff's day. An approach along this general line is the production of what Medawar has called "age-chimaeras", that is, individuals some of whose tissues are old and some young. At the first of the Ciba Foundation's Colloquia on Ageing held in 1954, Medawar described the ingenious experiment of taking skin from a young rabbit, preserving it in a state of suspended animation in cold storage, and then regrafting it on to the original, now senescent, rabbit. At the same colloquium Krohn described the exchange of ovaries between young and old mice of the same inbred line. These experiments were primarily concerned with the effects upon the grafted tissue of the relative age of the recipient. The complementary question remains open. For example, homogenised whole embryos can be injected into the abdominal cavity of mice of the same strain. Some of the cellular derivatives of the graft survive and differentiate *in situ*; it is probable that others are widely dispersed through the host organism. Might there not be an effect upon the ageing process *of the host*?

The Ciba colloquium mentioned above should be read as an antidote to the speculative vein which has characterised much of this article. There are sixteen contributions by medical and biological scientists who are actively engaged in research in the subject, together with the verbatim record of informal discussions among the thirty-four workers present. Much of the work consists in painstaking quantitative observations on the physical and biochemical changes which accompany senescence. Such work, although not productive as yet of any dramatic new clues, is vitally necessary as a base from which causal analyses and interpretations may ultimately be launched.

THE HUMAN PROBLEM

Several speakers stressed that human senescence, with which most of the papers were concerned, presents one special feature. It is both a social problem and also in some degree a social disease. When a man reaches retiring age the various social supports and incentives—work, money, the love and respect of his fellows—which have made his life worth living tend to be withdrawn. An abrupt decline, both physical and mental, not infrequently sets in at this stage. We do not know how far this decline is precipitated or hastened by his relative abandonment by society at the very stage at which he most needs its comfort. But it seems certain that the restriction of gainful employment which is made a condition of receiving the old-age pension, and the meagre level of the pension itself, does nothing to ease the problem. Some of the most practical and immediate questions of human senescence plainly require not biological, nor even medical, but socio-political solutions.

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ANNÉE GÉOPHYSIQUE INTERNATIONALE
1957 1958
INTERNATIONAL GEOPHYSICAL YEAR

THE INTERNATIONAL GEOPHYSICAL YEAR

MONTH BY MONTH

Compiled by Angela Croome

Summer's end is so much the time for plans and conferences that if we had adopted our usual separation of Planning News from the rest it would have swamped this month's bulletin. The Rio (Western Hemisphere) meeting, the Paris Antarctic conference, and the double meeting of CSAGI and ACIGY at Barcelona all fell within the period of mid-July to mid-September. The Paris and Rio meetings figure in this issue.

There have also been two important CSAGI new appointments recently, that of Co-ordinator of Operations and that of Sir Harold Spencer-Jones to be Editor-in-Chief of Publications, temporarily with a London office.

Antarctic According to Plan

The technique of exploring the Antarctic, like that of making war, is changing. The two are not unrelated. The logistics and communications tools developed for the "triphibious" conquest of Normandy beach-heads and for maintaining Russian convoys, have made possible new methods for attacking the Antarctic.

In the Antarctic as in battle, moreover, old and new styles continue side by side. The year 1956 has seen an American ten-ship naval task force filled with mechanised vehicles, men by the thousand, and prefabricated huts in scores, spreading along the shores of the Ross Sea; while, on the other side of the continent, eight men from Dr Fuchs' Trans-Antarctic Expedition have wintered under canvas preparatory to a 2000-mile journey on foot across that continent. This impression of old style and new style going on side by side is perhaps the strongest left by the recent Antarctic IGY conference in Paris—the third Antarctic planning conference to be held and the last there will be until the Year is over. "Rockoons" for upper atmosphere measurements are to be let off from Antarctica, yet the men who will fire them will travel on skis or behind dogs.

The main function of this conference was to confirm what had already been planned at last year's Paris and Brussels conferences. Also there were the reports of the advance parties launched in the Antarctic last season to be presented.

A hundred-minute film of "Operation Deepfreeze" made by NBC-television showed the Americans operating "new style", but not without casualties: they lost two men during last season's activities. Scientific papers were presented from a strong Soviet delegation. The Australians discussed nearly ten years' experience of South Polar research. The contribution of the Australian Ionospheric Prediction Service to CSAGI's Antarctic plans was recognised. French explorers reported success on ice, snow, and water, using skis, weasels, and landing-craft made entirely of aluminium.

During the assembly it was proposed that a combined-nation expedition should go to Norway's Bouvet Island, Kerguelen, Heard Island, Marion Bouvet, and a few others which form a loose ring of bleak, terrifying volcanoes round the Antarctic. At Bouvet, hundred-foot cliffs rise sheer out of the waters till they meet the descending ice-cap. Storms hatched or in transit at Bouvet reach Cape Town the next day; hence an interest both practical and scientific in the island. The South African Navy last season conducted an inconclusive reconnaissance of it. No successful landing was made. At the conference the Soviet delegation offered to transport and help establish an expedition on Bouvet from their large polar transport *Ob* when she returns to Antarctica from Leningrad this autumn. A South African weather staff would then presumably man the station.

The Russians were congratulated by the conference chairman on another suggestion. Prof. Pouchkov, a powerful figure at the meetings, proposed that in addition to the loan of personnel from other countries to gain experience at the Little America Antarctic Weather Central, there should be a more general exchange of scientists among the main Antarctic stations for brief periods, in the interests of greater international understanding.

CSAGI's New Officer

The Paris conference was for many IGY participants the first appearance of CSAGI's newly appointed Co-ordinator of Operations, Vice-Admiral Sir Archibald Day, until 1955 Hydrographer to the Royal Navy. He has an enviable reputation for getting things done—he is also "the most un-admiral-like admiral one has ever seen" as one Paris delegate remarked.

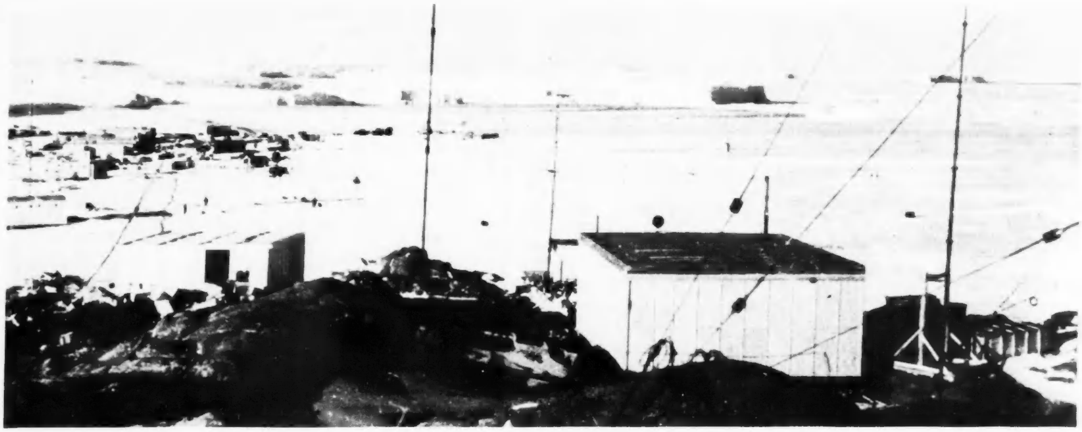
The new position has been created on the CSAGI staff "in view of the diversity of the IGY programme". It is a full-time appointment with offices in Brussels next door to those of the Secretary-General, Dr Nicolet, so that communication between Bureau and Operations may be as full as possible. Admiral Day's main concern will be "to assist in the co-ordination of operations and so help to ensure that the Year achieves its full promise" in the words of the official announcement. Under this general head falls the preparation of a CSAGI news bulletin, the co-ordination of World-Day activities, the appropriate circulation of information about the Earth Satellite operations, and the circulation of findings among the World Data Centres. He expects to spend as much time visiting IGY centres as at his desk in Brussels. Within less than a month of his appointment he arrived in Paris. CSAGI's summons had reached him on Lake Nyasa where he had been engaged on a hydrographic survey for the Nyasaland Government. Since that time he had checked in at his Brussels office and had also attended the CSAGI Western Hemisphere conference during July in Rio de Janeiro.

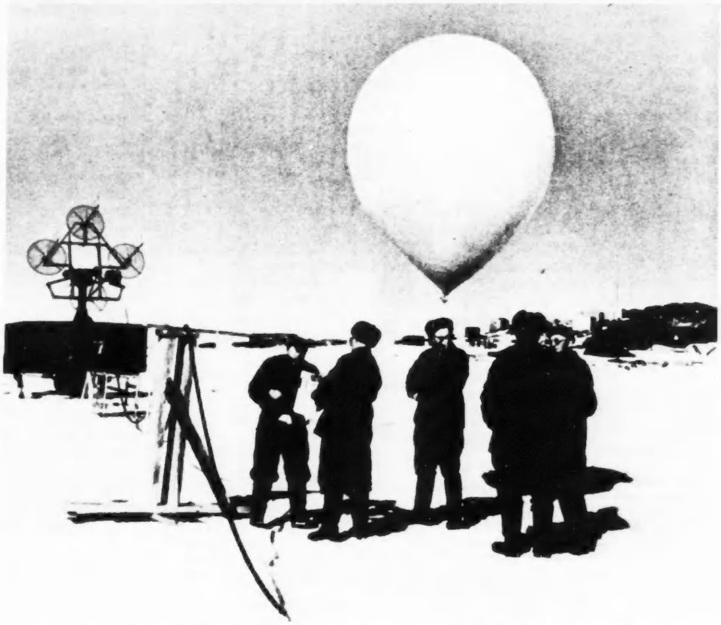
The Rio Conference

Asked about his impressions of the Rio conference Admiral Day said that the United States took a leading part "as was natural": but there was plenty of interest in the IGY among South Americans. An important feature of the meeting had been the session on the Earth Satellite. The satellite's orbit takes in a number of South American countries.

Radiometers do not Agree

At the Meteorological Observatory, Fühlsbuttel, near Hamburg, the third of a series of annual trials of net-flux radiometers was held recently, under the auspices of the Radiation Commission of the IMA (International Meteorological Association). The purpose of these trials has been to narrow the discrepancies in calibration of the instruments produced in the laboratories of different countries. Though not arranged by CSAGI, the relevance of these trials for IGY is obvious and the organisations taking part had the IGY well in mind. Instruments designed in Britain, Finland, East and West Germany, and





(*Top*) The Russian station at Mirny in the Antarctic, with a general view of the prefabricated huts and wireless masts.

(*Bottom*) A view recently taken at the Russian station of the Antarctic at Mirny, showing a radio-sounding balloon, being launched, with a radar listening post on the left, for recording the balloon's flight.

Switzerland were compared; the observers from the U.S. and South Africa attended the closing stages. Britain has not taken part before; the radiometer she presented for comparison this summer has been developed at Kew Observatory.

For many years now short-wave solar radiation has been studied, and the instruments employed use one of two generally accepted scales. It is only recently that satisfactory instruments for measuring the net-flux of radiation in the field have been developed. In effect such instruments measure the difference between incoming radiation—mostly solar short-wave—and the outgoing radiation reflected back from the Earth's surface.

Both the British and the Davos instruments employ artificially ventilated blackened arrays of thermocouples, the type handiest for fieldwork. The Davos instrument was a fine piece of apparatus—handsome, of exceptional workmanship in the best Swiss watch-making tradition, and unique in the trials. It is, however, much more costly than the British instrument, and unnecessarily elaborate for fieldwork.

When engaged on its programme of solar, atmospheric, and terrestrial radiation measurements during the IGY, the British Meteorological Office is to use this instrument in unmodified form. Radiometers will be operated in the Antarctic, at Aden, Malta, and in the United Kingdom. They will also be operated on four British Weather Ships as a result of trials recently completed. Thirty net-flux radiometers are at present being built at Kew for the IGY programme.

After more than fifty years of work, international agreement on a single scale for solar short-wave radiation measurements is only now in sight.

Through the Surf to Achimota

The University College of the Gold Coast, Achimota, has just announced a programme of IGY research. This will be undertaken by three of the Physics Department staff under the chairmanship of the Professor, Dr H. E. Huntley.

Dr Huntley has been in charge of physics at Achimota almost since the college was founded in 1948. For the past half-year he has been on special leave in this country to investigate for the Gold Coast Government the best type of nuclear reactor for supplying the electrical needs of the territory. It is proposed as a preliminary step to set up at the university an Isotope Training Centre and an experimental reactor.

Achimota hopes to carry out work in three of the main IGY fields, the most individual being undoubtedly research on the correlation between changes in the Earth's magnetic field and the ionosphere's variations. The latter have been recorded for the past four years.

Father J. R. Koster, an American priest and the Physics Department's radio astronomer, has just returned

CHECK-LIST ON POLAR SHIPS IN THE ANTARCTIC NEWS

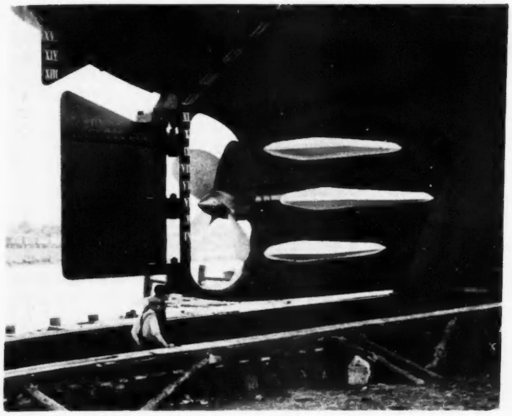
Name	*Tonnage and h.p.*	*Originally*	*Now*	*Other Points*
M.V. *Tottan*	540 900–1200 h.p.	Sealer. Built Goole, 1940	Royal Society Expedition ship 1955–6.	Used by British North Greenland Expedition. Adopted by Royal Society 1955 when *Jopeter* crushed in Greenland ice.
M.V. *Theron*	829 1350 h.p.	Sealer. Built for Canada, 1950. James Lamont, Greenock, Scotland.	1955–6 Trans-Antarctic Expedition ship.	Insurance pushed costs to £350 a day. Aluminium superstructure.
H.M.S. *Protector*	3600 9000 h.p.	Built 1936, Yarrow. In war-time net-layer with Royal Navy.	Naval polar patrol ship for support work with FIDS.	Ice-strengthened; not suitable for heavy ice. Carries two helicopters.
R.R.S. *Shackleton*	1000	Polar cargo and passenger ship built 1955, Solvesborg, Sweden.	Bought August 1955 by FIDS, now Royal Research ship for FIDS.	1955–6 her first season in Antarctica.
R.R.S. *John Biscoe*	2250 1350–1450 h.p.	Royal Research ship for work with FIDS. June 11, launched Fleming and Ferguson, Paisley, Scotland. Will be in Antarctic this season.		Plated hull of "Coltuf 28" steel gives Lloyds 100 A1 "strengthened for ice" grade. No crowsnest steering but high bridge.
M.V. *Pretext*		(See below—H.M.N.Z.S. *Endeavour*.)		
M.V. *Magga Dan* (sister-ship *Kista Dan*)	1650 2200 h.p.	Polar cargo and passenger ship. June 1, 1956, Aalborg, Denmark for J. Lauritzen Lines.	1956–7 joint expedition ship for Royal Society and Trans-Antarctic Expeditions.	All-welded steel hull gives ice-worthiness much in excess of Finnish 1A. Holds may be either cooled or warmed for tropic and polar work.
M.V. *Oluf Sven*	900	Polar cargo and passenger ship, Denmark.	Hunting Aero-survey Expedition ship for Governor, Falkland Isles, after modification in Jarrow docks.	Expedition's object to map in two seasons 50,000 square miles. One helicopter operates from aft flight-deck.
General San Martin	4500 6600 h.p.	Naval ice-breaker. 1954, launched, A.G. Weser Werk, Bremerhaven, Germany.	Argentine Navy.	Used to establish Base General Belgrano 1955 on Filchner Ice Shelf. Cost over £1 million.
M.V. *Kista Dan* (see above)	1200	1952, launched Aalborg, for J. Lauritzen.	Australian National Antarctic Research Expedition ship.	This coming season will be ship's third season with ANARE and her fourth Antarctic season. She plies the Greenland trade the rest of the year.
M.V. *Norsel* (sister-ship *Polarsirkel*)	592	Polar cargo and passenger ship built post-war in Norway, ? Tromsö.	French Antarctic Expedition ship 1955–6–7.	This season's voyage will be *Norsel*'s second to Terre Adélie.
M.V. *Soya*	2400	Ice-strengthened lighthouse relief ship built pre-war.	Japanese Antarctic Expedition ship 1956–7 after thorough redesign in Yokohama docks.	This will be *Soya*'s first voyage to Antarctic. Now classed as light ice-breaker, she will carry 130 people.
Omitaka-Maru	1450	Ice-strengthened transport ship for Japanese Antarctic Expedition. Launched August 1, 1956, Yokohama.		
M.V. *Polarsirkel* (see above)	600	Polar cargo and passenger ship built post-war at Tromsö, Norway.	Norwegian Antarctic Expedition ship 1956–7.	*Polarsirkel* will transport an expedition party of forty men.
H.M.N.Z.S. *Endeavour* (same as ship in which Cook circumnavigated New Zealand, 1769)	890	Ice-strengthened polar ship after extensive reconstruction from war-time net-layer.	Bought July 1956 from FIDS for use by Ross Sea Committee for joint IGY and New Zealand Trans-Antarctic Expeditions.	Will the ex-*John Biscoe* be the only wooden hull off Antarctica this year? This the ship's tenth season in Antarctica.
U.S.S. *Glacier*	8300 21,000 h.p.	Naval ice-breaker, launched 1955, from Ingalls' yard, Pascagoula, U.S.A.	U.S. Navy. The lead-ship of 1955–6, "Operation Deep-freeze".	Largest ice-breaker ever built in America. Prototype for future construction.
U.S.S. *East Wind*	6500	Naval *Wind*-class ice-breaker.	U.S. naval "Operation Deep-freeze".	Broke a propeller-shaft during "Deepfreeze I".
U.S.S. *Edisto*	6500	Naval *Wind*-class ice-breaker.	U.S. naval "Operation Deep-freeze".	Broke a propeller-shaft during "Deepfreeze I".
M.V. *Ob* (sister-ship of *Lena*) *Jenissei, Angara* M.V. *Lena*	12,500 17,000 h.p.	Ice-strengthened merchant ships. 1954, launched from De Schelde's yard, Flushing, Holland.	Soviet lead-ship in Antarctic base-establishing mission 1955–6. Accompanied Soviet 1955–6 Antarctic Expedition.	Named after Russian rivers. Sister-ships *Jenissei* (1954) and *Angara* (1956), constitute with these a team, that in heavy ice can push as one unit. The stem of each ship incorporates a depression into which the bow of a sister ship may fit. Total h.p. then 28,000.
Soviet *Refrigerator Ship No. 7*	—	No technical details.	Accompanied Soviet 1955–6 Antarctic Expedition.	

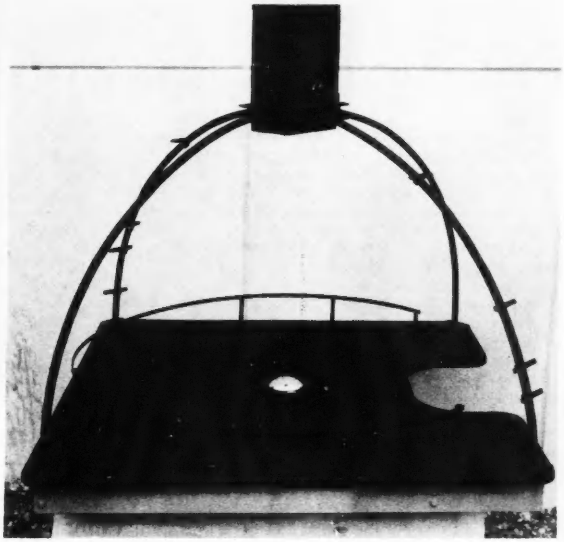
No details of Chile's ships. The following are the naval ships used for relieving the bases round Graham Land. Frigates: *Iquique, Covadonga*. Tankers: *Maipo, Rancagua*. Patrol boats: *Lautaro, Leucoton, Lientur*.

For comparison, here are some data of **Expedition ships of an earlier day.**

Endurance 829 tons Shackleton's 1916 South-Polar Expedition ship was powered by steam in addition to canvas. Tonnage, same as *Theron* but with 1301 less horsepower.

Resolute 462, *Adventure* 336 — In these ships Cook in 1773–4 reached 71°10′ S; this brought him within 1200 miles of the South Pole. The object of the expedition was to find "a great antarctic continent". It was sponsored by the Royal Society.





(*Above*) Special protection fins to prevent ice from fouling the propeller of the *John Biscoe*. (*Photograph by Ralston Ltd., Glasgow.*)

(*Right*) All-sky Aurora Camera. (*Courtesy of Mr James Paton of Edinburgh University and the Royal Society.*)

from a visit to the States where he was able to buy the very sensitive magnetometer required for measuring the smaller changes in the Earth's magnetic field at the equator. The Gulf Petrol Corporation is the only concern in the world known to have precisely the apparatus he required. He returned to the Gold Coast with the instrument in his luggage, thus saving time and much worry. The normal route for scientific apparatus travelling to the Gold Coast is via the port of Accra where the harbour is fenced off by a sandbank so that all freight must be landed through the surf in open surf-boats which shoot the breakers, guided by African oarsmen. These boats often spill and the merchandise goes to the bottom, which is fortunately shallow. It is not, however, the depth but the damp that mainly effects the physicists' apparatus. Apart from Father Koster's magnetometer, most of the other equipment required specially for the Gold Coast's IGY programme will be landed through the surf at Accra.

Research on cosmic rays and earth currents is also to be undertaken. Dr A. H. Ward, who has previously worked on the effects of strontium for Harwell for two years, is organising the **cosmic ray activities.** These will reinforce the meson observations, at Makerere in East Africa (see DISCOVERY, 1956, p. 248) so that direct comparisons can be made across the centre of Africa. The apparatus is expected from England by the end of the year. Some cosmic ray apparatus has been operating at Achimota for some time. Some records were obtained of the highly significant cosmic-ray disturbances that occurred in conjunction with the February 23 solar flare. It will be simultaneous round-the-world observation of such phenomena interpreted in relation to other standard measurements that will give the IGY much of its unique value. The Gold Coast is not proposing to have a neutron recorder; neutron radiation at the equator is thought too small, and in any case Uganda will be keeping a watch on this.

Records will be made of **earth currents** in both north-south and east-west directions, using a Honeywell-Brown electronic-recording potentiometer with chart speeds of 6 inches to 120 inches to the hour. The instrument should be in Achimota by Christmas. An auxiliary instrument which will give a photographic record is to be built in the department's workshops for periodic operation at a distance from the main instrument. Miss Rosemary Hutton is in charge of this and the other work in geomagnetism.

All-Sky Aurora Camera

Since May 14 Dr Stanley Evans, the physicist with the British IGY advance party at Royal Society Base, Antarctica, has been carrying out a regular night routine of visual and photographic observations of the *Aurora Australis*. The camera used for the observations photographs the whole sky at one-minute intervals, with exposures of 15 seconds, and is heated (with thermostatic control) for operation out-of-doors in Antarctic conditions; it is automatic (Fig. 1). In the centre of the horizontal baseboard may be seen the convex mirror; the image of the sky in this is photographed by the 16-millimetre cine camera suspended above, and so also is a watch-face illuminated briefly during each exposure and set beside the mirror.

This is the first of these very recently-developed instruments to be operating in the Antarctic. The work on them being undertaken at the Geophysical Institute, College, Alaska, was specially hurried on at the instigation of the aurora expert, Mr James Paton of Edinburgh. They were briefly tested under polar conditions in Alaska, and further adaptations were carried out in this country under Mr Paton's guidance. Last November the instrument was embarked in *Tottan* for the south.

The full record of auroral activity provided by the all-sky camera should prove invaluable, not only in establishing precisely the extent of each display, but in yielding data for fixing the bearing in the sky at which an aurora display takes place—the key question in aurora studies.

The classification of polar ships is not readily standardised yet some basis of comparison is necessary. A broad distinction should be drawn between ice-breakers—*heavy ships (much of the weight deriving from the ice-armour) of great power and small cargo-capacity which batter a way through ice—and* ice-strengthened vessels—*small, sprightly ships (but of good cargo-carrying capacity) that can wriggle and dodge through the floes. There is a marked difference in navigational technique as well as in weight and design between these basic categories of polar ship.*

The Polar Record *(January 1956 issue) cites three grades of ice-breakers (based on Russian classification), and six classes of ice-strengthened vessels, based on the Finnish Board of Navigation's standards of ice-worthiness. The four superior grades in the Finnish classification all make demands additional to those required for Lloyds 100 A1 grading; they are 1A, 1B, 1C, and 11A, 1C is equivalent to Lloyds 100 A1 "strengthened for navigation in ice"—the highest classification Lloyds gives.*

THE BRITISH ASSOCIATION

Prof. J. Drever's Presidential Address to the Psychological Section of the British Association might well serve as sensible leavening to the mass of highly specialised nourishment fed to the 3000-odd members who attended Sheffield during the 1956 Annual Meeting. While affirming the neutrality of science, "aware"—as he said—"of its diabolic as well as its angelic potentialities", he was careful to place science as a whole, and certainly its innumerable sub-divisions, in their proper relationships to one another. If we call a tiger a big striped beast, or Felis tigris, *or "Tiger, tiger, burning bright" one of these statements is as valid as another. Failure to recognise so simple a fact does seem to have led many scientists into their most awkward dilemmas, though the most rigid of behaviourists would scarcely have the temerity to ask his wife for the salt by saying, "Fetch it, Rover!" The keynote of Prof. Drever's address was "relationships", and it is precisely in an understanding of relationships that science is particularly lacking today.*

Some "asides" by scientists themselves about their deficiencies are revealing. Dr E. Elliott, reporting on auditory vigilance tasks, admitted that all observations have been on distorted behaviour and that it would be good now to begin studying the normal: a suggestion many social scientists might profitably take up. Also in the symposium on vigilance Mr D. E. Brockbent said that the psychologist was in the same situation as the physicist in relation to the atom, for he could only find out about man's state of vigilance at the instant when a response was expected of him; what went on between responses—presumably the determining period—was unknown.

To an uninvolved observer at the meeting, it seemed that it was precisely gaps of this kind in scientific knowledge that are interesting. The most important and fascinating gaps exist between specialty and specialty, and until these are filled, science seems to be giving us a fragmentary and incoherent view of things. Perhaps a new philosophy of science is needed, which will, out of the vast areas of the unknown, assess what is worth *knowing, and for what* total purpose.

Later in the meeting, Sir Henry Tizard and others discussed the possibility of combining arts and science courses at universities; Prof. Drever's address had a bearing on this problem; indeed, the recurring question at this year's B.A. meeting was how to avoid isolation and over-specialization, and how to relate and co-ordinate all branches of human knowledge. It is a question already implied in the article by Derek Price in DISCOVERY *for June, 1956, p. 240. Science is reaching saturation point, and we should be asking some fundamental questions about its purpose and future development.*

A detailed report of all the papers given at the meeting is of course impossible: but a few of the more interesting observations can be commented on.

Cyclosteel

Sir Charles Goodeve's announcement of the new "Cyclosteel" method of steel making has been widely reported in the Press. He said that this new method would not supplant the blast furnaces, but its value was that it could cut out coke ovens and sinter plants. The process is best suited to an ore that is already in a finely divided state. It is preheated and then injected into a very hot reducing gas. Sir Charles Goodeve admitted that the technical obstacles are still formidable; on the other hand a method for making steel from powdered ore and coal is "extremely attractive".

The Taste of Water

Prof. Y. Zotterman of Stockholm has proved that mammals do have taste fibres specific for water, and that the graph for water-fibre stimulus is reciprocal to that of NaCl. (One remembers that T. E. Lawrence alleged he could distinguish by taste between waters from different desert wells: it seems his taste fibres were unusually developed.)

"A Little of What You Fancy"

Some years ago workers experimenting with parathyroidectomised rats found that these rats instinctively chose a diet rich in calcium. Now Dr J. G. Gordon, Scientific Officer at the Rowett Research Institute, has evidence that "a little of what you fancy" is not such a reliable mechanism, since sheep, it appears, will die rather than eat what they find unpalatable.

Rock Magnetism

About fifty years ago it was discovered that some rocks were magnetised in the opposite direction to the present magnetic field of the earth.

SIR GEORGE ALLEN, the permanent Secretary of the British Association. His careful planning and organisation, ably assisted by J. Robertson, have made recent meetings of the B.A. a pleasure for authors and audiences.

Now, according to Prof. P. M. S. Blackett, we know that about half the rocks are reversely magnetised. One finds a number of layers of rocks magnetised normally, then a number magnetised reversely, then a normal layer, and so on. Such results suggest that the earth's magnetic field has repeatedly reversed itself during geological history, although a number of complicated physical and chemical processes are known by which rocks can become reversely magnetised. Study of the magnetism of rocks should be able to settle whether the Continents have always had their present positions relative to each other and to the geographical poles. It is now known that England has moved a long way northward in the last 150 million years, from a position near the equator. North America has moved somewhat similarly, and the gap between Europe and America seems to have widened by over 1000 miles. India and South Africa seem to have moved farther from the South Pole, and there appears to be a relative continental drift as well as a movement of the crust as a whole.

Radio Stars

It was discovered in 1948 that there are astronomical bodies acting as intense point sources of radio noise in the same way as there are point sources of light, called stars. The two most intense sources of radio noise remained unidentified until 1951, when Dr Smith of Cambridge measured their positions. There is a source in Cygnus which is receding from us with a speed of 10,000 miles per second. The light and radio waves from it take 300 million years to reach the earth. Investigation showed that it is two galaxies in collision. At the end of his paper on these findings, Mr J. R. Shakeshaft of the Cavendish Laboratory observed that "conclusions may be drawn about different cosmological theories, i.e. that the Universe is evolving with time and is not in a steady state."

High-Speed Photography investigates Glass Fibre

In the Osens-Corning glass wool process, glass fibres are produced by subjecting streams of glass issuing from platinum orifices to a vertical, superheated steam blast. Naked-eye observation suggests that the streams of glass are shattered inside the steam blower, and it was thought that the droplets thus formed were drawn into fibres. A. de Dani and P. E. Jellyman examined the process by means of high-speed cinematography at 3000 f.p.s. and found single streams of glass in violent side-to-side oscillation inside and immediately below the steam blower. This oscillation creates the illusion that several fibres leave the blower simultaneously. It is concluded that splitting of the main glass streams in the blower is not the chief mechanism of fibre formation. The streams seem to be broken along their length at a later stage, after looping and folding, to form individual fibres.

Chemistry at Very High Temperatures

Prof. George Porter of Sheffield University described special techniques used to study chemical changes which are all over in a few millionths of a second. One new technique uses a "shock tube", which involves the bursting of a diaphragm by pumping up the pressure on one side of the diaphragm higher than on the other. When the diaphragm bursts a temperature much higher than the surface of the sun can be produced (see also p. 406). A second method consists in irradiating the gas with an intense flash of light.

One of the interesting things about chemistry at high temperatures is that when we look at the substances which are present we find many molecules which are chemically unstable at lower temperatures. For example, the blue light of an ordinary gas burner is nearly all emitted by the diatomic carbon molecule C_2, which is quite unknown at ordinary temperatures. At high temperatures "things go so fast that the molecules cannot keep up and we get to the point where 'temperature' no longer has any clear meaning".

Genetics of Micro-organisms

Prof. D. G. Catcheside from the University of Birmingham said that recent progress in this specialty extended to bacteria and viruses, and depended upon the explanatory work with nutritional mutants in the fungus *Neurospora*. Similar mutants could be obtained in bacteria, and these allowed selective enrichment techniques to be used in the search for sexual reproduction in these organisms. Comparable methods showed similar behaviour in viruses. The advances secured are threefold. The way is opened to a closer knowledge of the physiology of gene action. The whole field of bacterial and virus genetics has become accessible. Material for the study of the rare event of mutation is provided by the large populations possible with bacteria.

Mutation in a Single Gene

Dr V. M. Ingram of the Medical Research Council's unit at the Cavendish Laboratory, described how a mutation in a single gene can modify chemical structure in a substance in the body for which that gene is responsible. The gene is that of sickle-cell anaemia. Dr Ingram has shown that there is a chemical difference between haemoglobin of normal individuals and those with sickle-cell anaemia. He has done this by chromatography of haemoglobin. On his filter-paper, twenty-nine of his spots fell in the same positions in both cases. The thirtieth spot always fell in different positions according to whether the haemoglobin was from a normal individual or one with sickle-cell anaemia. The fragment of the protein molecule which this spot represented is therefore chemically distinct in the two cases. It is probably a chain which may contain about 10 amino-acids, but the exact composition in the two cases has yet to be determined.

Moth Camouflage

In the industrial areas of Britain, and also in North Germany, whole populations of moths have in the last 100 years changed from light colours to black. Dr H. B. D. Kettlewell reported at the B.A. a survey investigation near Sheffield. Many species of moth are turning black in this area though they have not so far produced melanic forms in other places. There is also evidence that certain species of moths which had previously been driven out of Sheffield are now re-invading it, but this time in a melanic form. One of the main causes of this is the conspicuousness of the old light forms on the blackened and lichen-free tree trunks in polluted countryside. Conversely, dark mutations before the period of industrialisation must have been rapidly eliminated. A moth, it seems, should never be conspicuous.

Vocal Signals in Birds

Dr P. Marler of Jesus College, Cambridge, said that the types of bird neighbours with which a bird has to live differ in different parts of the world. Therefore it is sometimes more necessary that there should be a distinction in the song of one and the same kind of bird in one location than in another. The end part of the chaffinch's song in parts of Russia is shorter than it is in Western Europe. Even in England, the endings of the song of a given species of bird differ in different parts, like human dialects. Birds brought up in captivity do not learn the local dialects!

Computer-Controlled Machine Tools

The application of digital computer and feedback techniques to problems of measurement and control have allowed machine tools to be made which give fully automatic production. The system which has been developed, and which was described by Mr D. T. N. Williamson of Messrs Ferranti Ltd., Edinburgh, uses a digital computer capable of supplying a large number of controlled machine tools with magnetic control tapes. The function of the computer is to accept basic dimensional and machining information about the component to be made, and from this to calculate the movement of the centre of a cutting tool in order to machine the component. This information is recorded on a magnetic tape, which is then placed in the reader of a control unit, associated with the machine tool. This in turn controls a servo-mechanism to move the machine-tool slides in accordance with the instructions from the magnetic tape. By this means, the slides can be made to execute the required movements at high speed and with great accuracy, while machining the component.

The system has been designed to be used by people with ordinary workshop qualifications, and it requires no more skill than an intelligent operator would possess. The possible uses of a control system of this type go far beyond the limited field of machine tools, and the principle is applicable to all industrial processes.

Ancient Glass at Glastonbury

Last summer Mr Ralegh Radford found a glass furnace on the site of the cloister of Glastonbury Abbey. Dr D. B. Harden, Keeper of the Department of Antiquities at the Ashmolean Museum, Oxford, described how the remains of a firing chamber and fragments of furnace pots and glass indicated that not only glass-making, but also glass-blowing, had been performed on the site. This is the first tangible evidence of glass-making in Saxon England, glass furnaces earlier than the 16th century being extremely rare in any country.

Physiological Diurnal Rhythms

Dr Mary Lobban of the Physiological Laboratory, Cambridge, described two expeditions to Spitsbergen to study the effects of prolonged periods of life on abnormal time routines upon physiological diurnal rhythms in man. In 1953, 8 people lived for 6 weeks on a 22-hour "day". In 1955 one group of 7 people lived on a 21-hour "day", and another group of 5 lived on a 27-hour "day". Urine samples were collected regularly, and analysis showed that rapid adaptation of the urinary rhythm to an abnormal routine is uncommon. People who failed to adapt to the environmental time routine showed signs of stress, particularly when their excretory rhythms became greatly disorganised. The experiments provided evidence for the persistence of the intrinsic, 24-hour rhythm of kidney function in some humans, and indicate that the mechanism which controls the normal diurnal

variations in body temperature is not the same as that controlling the excretory rhythm.

Drs H. E. Lewis and J. P. Masterton, on the British North Greenland Expedition of 1952–4, examined sleep and wakefulness patterns on a polar expedition. The effect of the winter darkness severely disrupted the usual pattern of sleep. Men took naps, and periods of interrupted sleep. In the spring there was a return to the more usual pattern, but this was again disturbed with the coming of the midnight sun. Individuals whose social and disciplinary background was similar varied greatly in their sleeping habits. When the monthly sleep was totalled, however, there was little difference over the two years. During the dark periods members were going to bed and taking naps at all times, but were not sleeping excessively. The mean amount of sleep was 7·9 hours, even though the men were allowed to sleep practically as long as they liked and whenever they liked. The approximate period of eight hours' sleep in temperate countries seems thus to represent a normal demand.

Measuring Energy

Dr R. Passmore of the Physiology Department, Edinburgh, described how measurement of oxygen consumption enabled energy expenditure to be calculated. Recently German physiologists at the Max Planck Institut für Arbeitsphysiologie have designed a portable respirometer which measures the volume of expired air and diverts some of it into a rubber bladder for analysis. With this instrument measurements of rates of energy expenditure can be made at work, in industry, and in the home. It is hoped by this means to study such problems as the effect of the introduction of domestic appliances on the energy expenditure of housewives!

Arctic Plant Growth

Mr J. Warren Wilson, Lecturer in Botany at Reading University, described experiments in the Arctic using *Oxyria digyna* (mountain sorrel) and *Brassica rapa* (turnip) which showed that the growth rates of these plants even under Arctic summer conditions are far lower than those in temperate lands; they are depressed both by the low temperature and also by the infertility of the soil. The relatively luxuriant vegetation round lemming and fox burrows, polar bear lairs, bones, and so forth, suggests that nutrient deficiency may be responsible for the general infertility; and experiments and analyses of plants show that there is extreme nitrogen deficiency, and that this limits the growth of plants on even the most favourable soils. While other nutrients are derived from the parent rock, soil nitrogen is accumulated by the activities of soil micro-organisms; and these are inhibited by the low temperatures and the poor supply of organic material.

Wind Power and Heat Husbandry

Agriculture and food production in every country in the world use the twin skills of plant husbandry and animal husbandry. It is now proposed to add to these a third skill: heat husbandry. Mr A. W. Capps described how heat in unlimited quantities and at a suitable temperature can be applied to the drying of crops, to the heating and cooling of living-rooms, and to the production of methane gas for power purposes. Heat husbandry would use wind power to draw heat from the atmosphere and store it in the subsoil immediately below the farmstead. No land would be wasted, and any heat leakage from the heat store would warm the surrounding soil and make it better for crop-growing. Warm places could be cooled, and cool places warmed without the use of a power station and consuming a minimum of mineral fuel.

Astronomy at a Public School

At Charterhouse School in 1907 an observatory was built on to a block of science laboratories and was equipped with a 10-foot diameter copper dome and a 6½-inch reflecting telescope. In 1936 this society was revived, but activities had to be suspended on the outbreak of war in 1939. In 1953 it was again revived, and Mr Keith L. Watson described at the B.A. studies undertaken on Sun and Moon. The Moon has been mapped, particularly those portions of it which have not otherwise been charted in great detail. Cycles of sun spots have also been plotted.

A Schoolgirl Corrects the Textbooks

B. Anne Bunting of Thorne Grammar School gave a talk on "Some little-known and unpublished aspects of the life history and habits of *Periplaneta americana* L. (Insecta, orthoptera)", in other words the large American cockroach. Having reared the cockroach under artificial conditions for several years, Miss Bunting said, "It has become obvious that some of the data given in textbooks dealing with this insect require correcting." Given the optimum temperature requirements, the eggs incubate in 28–9 days. Previous workers gave a far longer incubation period. The incubation period lengthens as the temperature decreases, until no incubation takes place at 50°F, which partly explains why the species has failed to become widely established in Britain. Humidity had no effect on incubation. Under optimum conditions for growth, the period from incubation to final moult is from 3 to 4 months, and not, as given in the textbooks, 3 to 5 years (or, as in more recent papers, 11 to 14 months). The usual opinion that the wings are unfolded by gaseous pressure was not confirmed by her observation. The testes function for all or most of adult life and not, as is generally supposed, in young males only. Females fasten or bury their cothecae in or near suitable foods. The fungoid parasite *Netarrhizium anisopliae* (Metsch) may attack the female genitalia, preventing the production of cothecae, and this fungus may also be responsible for the fact that the cockroach has never become widespread in Britain.

Effects of Television

To determine the precise effect of television on its audiences is not an easy scientific task, particularly so if children are the viewers. American investigators found it possible to claim that children read more after seeing television, whereas others could equally easily prove that they read less; simply because no control children were available which did not regularly view some programmes each day. In this country two research projects have been running for some time, and Dr H. Himmelweit, Department of Psychology, LSE, and Dr W. A. Belson, Audience Research Department, BBC, reported their methods and findings at the B.A. Dr Himmelweit took a large sample of children who viewed television in Bristol, Portsmouth, and Southampton, and matched them in age, sex, educational background, and so forth, with a similar number of non-viewers. These were carefully questioned and detailed statistics of the result are in preparation. Perhaps even more interesting was her work in Norwich, where children were questioned on the way they spent their time both before and after the introduction of television to that city. She gave as her preliminary conclusion that children selected their own programmes and fitted them into their lives according to their individual basic needs. Miss B. R. Winstanley in a second paper, made a thorough comparison of films and television as educational media for children; she stressed the need for a high standard of transmission and active co-operation at the school, and concluded with a stimulating outline of the future potentialities of television in schools.

Dr Belson started his inquiry on 800 people in Greater London in 1954. He devised a special technique, the stable correlate technique, and found that only 6% of those approached, refused to collaborate. His most interesting finding was that personal interests and initiative due to the viewing of television were lost to an extent of about 15% during the early years of set ownership. Recovery then began, and was nearly complete after viewing for about five years. The interests which were reduced included cinema- and theatre-going, ballet, politics, and reading, but television increased interest in soccer matches, show-jumping, and paintings. Apparently the influence of science television programmes on viewers has yet to be investigated. His inquiry was not an official BBC responsibility, although funds were contributed by the Corporation and the University of London.

Exhibitions

Among the exhibitions at this year's B.A. meeting the trade show of scientific glassware was a new departure. All major manufacturers had taken a laboratory bench, on which they showed their standard equipment. New was the Flexicon interchangeable joint, which is an intermediate step between the rubber bung and the ground glass joint; its main advantage is its flexibility in a multiple assembly. Also new was a glass mercury vapour diffusion pump by Camlab Ltd. designed to overcome the disadvantages of back streaming when mercury diffusion pumps are used without liquid air traps. The Metal Box Company mounted a smaller exhibition in which traditional food-packs for Arctic conditions were compared with modern equivalents. The main difference is the almost complete substitution of thin evacuated plastic bags for the conventional tins, with great saving in weight. The packs used by Scott and Shackleton were vividly contrasted with those recently used on Mt Everest and on other recent—and future—British Expeditions.

Scientific Films

Films from various countries were run throughout the B.A. meeting. Whereas some of those from the United States were beautifully photographed, their commentaries tended to be either humourless and pompous, or lacking in the desirable talent of understatement; one commentator seemed to regard the plastic age as a kind of millennium. A film on electronic brains produced an authentic film star to rival "Robbie the Robot": he was an electronic mouse who became charmingly emotional about finding his way through a maze, and then, on his second run, performed as neatly as a circus acrobat. "Think of the Future", a British cartoon, lent a touch of humour to the problems of work study. Mr R. D. Taylor of FIDS is to be congratulated on his excellent colour photography in "67° South". Sir Raymond Priestley, who saw it, and admired it, must have reflected on the comforts enjoyed by the younger generation of Antarctic explorers: warm huts, plenty of living room, reading lamps, and radio contact with the outer world.

Research Films

The programme of research films, following the precedent set last year at Bristol, was an outstanding success, showing many new scientific research facets and a very wide range of cinematographic techniques. Perhaps Dr E. J. Ambrose's film dealing with the behaviour of normal and cancer cells in tissue culture, and recorded by interference cinemicrography in time-lapse, was again, as last year, the best of the whole programme. Epithelial cells were studied in some detail and the effect of physico-chemical tests, such as measurements of negative electrical charges on the cells, were recorded. A second research film from the Chester Beatty Research Institute, by R. J. Goldacre, was of equally high standard. It dealt with three new kinds of amoeboid movements namely, rapid cytoplasmic oscillations, cell rotation with suppression of noticeable cytoplasmic streaming and of locomotion, and the transmission of waves of contraction from one end of the cell to the other; it was filmed partly by phase-contrast and partly by interference microscopy in time-lapse. Another very good biological research film came from Dr P. N. Cardew of the medical photographic department of St Mary's Hospital Medical School. Earlier classical work on swarming of *Proteus vulgaris* was re-investigated by Dr H. Hughes. Particularly interesting were the sequences which dealt with the mutual interference of incompatible strains of bacteria and the effect of accumulated peroxide which acted as a toxic product. Also recorded at time-lapse frequency was a research film by J. Newkirk of the GEC, Schenectady, U.S.A., which showed the growth, evaporation, and phase-transformation of mercuric iodide crystals.

The interesting cinematographic technique of time-sampling was used by two research workers who presented their results to the audience of 350 which watched this successful programme. J. Robertson of the Tavistock Clinic demonstrated its use for an extensive study of the behaviour of a two-year-old girl in hospital. Filming the subject daily at regular times for standard periods, marked differences in behaviour patterns were clearly recorded; in the presence of the patient's mother, the child was happy and playful, while in her absence, she was fretful and depressed. Dr P. Sainsbury, Westminster Hospital, employed time-sampling cinematography to record the gestural movements of his patients before and after an operation of leucotomy, and of subjects with nervous tics. He flashed a signal light every five seconds, and counted as positive those five-second periods in which specified movements occurred, and as negative those periods during which the movements were absent.

Cinematography at normal camera frequency proved of great value in the film presented by J. H. Davies of the H. H. Wills Physical Laboratory, Bristol University, dealing with the launching of cosmic-ray balloons. If the initial acceleration of the rising balloon is too great, an undesirable mushrooming effect of the hydrogen bubble in the balloon occurs, thus leading to very high stresses in the envelope. Films were taken of each ascent during the development work to overcome this defect, to study all aspects of it in detail; a solution was achieved by releasing the balloon from a winch. Colour schlieren cinematography was employed by A. Chinneck of the Aerodynamics Division of the NPL, who demonstrated the high-speed air flow around a symmetrical aerofoil. The movements of shock-waves in sub- and super-sonic flow could be made visible by this cinematographic technique which would have otherwise remained invisible to the unaided eye; this excellent film was recorded by S. Beadle of the Shell Film Unit.

High-speed cinematography was used by a number of investigators. Relatively low camera frequencies, up to about 200 f.p.s. were useful to demonstrate the different behaviour of aircraft pilots and dummies when subjected to high air velocities on leaving their aircraft. Wing Commander F. Latham of the RAF Institute of Aviation Medicine, who demonstrated his research films would have found it extremely difficult to investigate the subject of aircraft escape without the slowing down of these rapid events. Particularly interesting were the colour shots of an ejection seat in operation while the aircraft was still on the ground on the runway. Similar camera frequencies were utilised in the research records presented by R. Silverleaf, NPL, Ship Division; his subject being the side launching of ships, both in model experiments and in full scale. The excellent photography was carried out by the Central Photographic Department of the NPL, often under the very trying conditions of being drenched by the ship's launching waves. The value of model experiments in work of this kind could not have been more clearly demonstrated than in the film record of a model overturning during a launching experiment in the tank. Camera frequencies of 100 f.p.s. with colour film, itself a remarkable achievement, were used by J. Underwood of the GKN Group Research Laboratory, in his investigation of flame movements in open hearth furnaces during tapping. Details of these movements could be seen with very great clarity revealing an uneven distribution of flames during certain stages of the process and the presence of patches of unburnt oil.

There can be little doubt that scientific cinematography is used with remarkable success in certain scientific investigations in this country. If these screenings of research films at the meetings of the British Association demonstrate the value of this powerful research technique to other scientists who have so far been unaware of its potentialities, they will have more than fulfilled the aims of the organisers of the meetings, the Scientific and Technical Group of the Royal Photographic Society, and Dr A. R. Michaelis.

A Smooth-Running Meeting

Finally the British Association is to be congratulated on its excellent arrangements. Meetings, receptions, press conferences, excursions and transport, all ran smoothly, due both to the permanent staff of the B.A. and the Sheffield authorities.

THE BOOKSHELF

Facing the Atomic Future

By E. W. Titterton (*London, Macmillan and Co. Ltd., 1956, 392 pp., 21s.*)

The human race cannot face the atomic future unless the fundamental fact is in everybody's mind: that we are standing at a crossroad, one path leading to a fair future, the other to disaster, and that no middle path exists. To choose the right way it is necessary that people are fully informed and clearly understand the issues involved. The purpose of this book is to spread information not only about the scientific situation in nuclear physics and engineering, but also about their economic, political, and military implications. The author is well qualified to do this. He belonged to the group of scientists who during the war developed the atomic bomb at Los Alamos. Later he held an appointment at Harwell, and he is at present Professor of Nuclear Physics at the Australian National University, Canberra. The book is introduced in a Foreword by another Australian, Prof. M. L. Oliphant, F.R.S., Director of the Research School of Physical Science at the same university. Thus the Australian point of view is particularly stressed throughout the book. But this does not in the least diminish its value and interest for the non-Australian reader.

The book is divided into three parts: (1) Atoms for Peace, (2) Atoms for War, (3) Social and Political Problems of Atomic Energy. All are full of valuable material. The first part begins with a condensed explanation of the elements of nuclear physics, the concept of fission and fusion, chain reactions, and critical mass. Then the different types of reactors are described. The following sections deal with the available energy sources in general, the need for atomic power, and the present endeavours in the U.K., the U.S.A., Australia, and other countries to satisfy this need. The uranium and thorium resources of the world and the possibilities of getting power from fusion are discussed. There is a report about other useful applications of nuclear energy, with a discussion of health hazards and disposal of waste products. The second part begins with an explanation of the principle of the fission bomb and of the effects of its explosion. Then follows the hydrogen bomb, radiological warfare, and the cobalt bomb, civil defence, the world-wide effects of atomic explosions, and the future of atomic weapons.

The last part of the book, on the human aspect of nuclear technology, is grim reading. It gives a short but clear account of the attempts to come to an international understanding and to "plan survival". The result is simple enough: "If mankind can avoid war, we can cross the threshold into a new era and look to an atomic future free from fear and pregnant with the possibility of improved living for all men, everywhere." What happens if this "if" fails to happen is left to the reader's imagination. MAX BORN

Dictionary of Gardening

Edited by Fred. J. Chittenden. 2nd Edition by Patrick M. Synge, 4 vols. 1956, £12 12s. Supplement Edited by Patrick M. Synge, 1956, 42s. (*Oxford University Press.*)

Until the appearance in 1951 of the first edition of this great work, the standard reference book for all matters concerning horticulture in this country was "The Illustrated Dictionary of Gardening", edited by George Nicholson, which was published in parts over the years 1883–9, with a supplement issued in 1900–1. Nicholson was Curator of the Royal Botanic Gardens at Kew and he freely used the vast literary, botanical, and horticultural resources of that establishment. His Dictionary was an indispensable reference book and it was, and indeed still is, held in high esteem by gardeners and botanists. But the present century has witnessed tremendous advances in horticultural practice and in the introduction of new plants to gardens both by breeding and by exploration. There has also been a remarkable expansion of interest in gardening. Particularly noticeable during the past fifty years has been the number of magnificent species which come to our gardens from the eastern Himalayas and neighbouring areas of south-eastern China. This region is the home of an exceedingly rich flora with a very high proportion of beautiful plants which may be grown in this country. From these parts there has been a notable influx of species of *Rhododendron*, *Gentiana*, and *Meconopsis*. Thus there was a need for a modern, authoritative, and comprehensive work of the type of Nicholson's Dictionary, and the Royal Horticultural Society appointed Mr F. J. Chittenden to undertake the prodigious task of compiling a new gardening encyclopædia.

Unfortunately a good deal of Chittenden's work was done during the war at his country home when he did not have access to essential botanical and horticultural literature or contact with leading specialists. Nevertheless, Chittenden completed the work of this Dictionary before he died in 1950. Thus there is a good deal to criticise in the first edition of this work, though its publication must be acclaimed as a magnificent feat. The progressive Council of the RHS, ever alert to keep abreast of new developments and encourage the study of horticultural matters, decided to publish a supplement every five years. The first supplement has appeared simultaneously with a second edition of the Dictionary in which many corrections have been made; and when that has not been possible in the four volumes, major amendments are included in the supplement. No effort has been spared to give up-to-date coverage for all gardening techniques and guidance on propagation and culture.

At some points botanists may cavil, as, for example, the omission of authorities for the plant names used. Again some treatments of genera lack the authority of mature botanical judgment, though much has been done in the supplementary volume to correct this limitation. Many of the plates drawn for the Dictionary are sadly deficient and fail to give a proper representation of the plant. This undertaking is, however, a great achievement and gardeners and botanists are as indebted to the RHS for this as they are for the *Index Londinensis* and *Curtis' Botanical Magazine*. It is gratifying to have a learned society so enlightened in the matter of publications, and it only remains for gardeners and botanists to show their appreciation by acquiring the Dictionary. It is without doubt one of the most important horticultural works ever to be produced in this country, and the Society and Editor are to be congratulated on its excellence. GEORGE TAYLOR

Personality and Group Relations in Industry

By Michael P. Fogarty (*Longmans, Green and Co., 1956, 341 pp. 30s.*)

Mr Fogarty takes the basic unit of society—human personality—and shows how this combines with and affects the working group, and through these, large groups. This approach to industrial relations by synthesis from the unit rather than by analysis of the mass has much to commend it; especially in the study of problems of the less skilled and therefore, in general, less adaptable members of the community.

The author compares his approach to that of the "atom smasher" in the natural sciences, and argues the merits of the unit-to-the-mass, or "inside out" approach, as against the mass-to-the-unit or "outside in" approach. Surely what the Rutherford and succeeding schools of nuclear physicists showed was that the atom, which had earlier been thought to be the ultimate unit,

was in fact a complex structure. They then analysed the atom. Their approach was as much "outside in" as that of the classical physicists and chemists. "Atom smashing" is not an alternative to older approaches in natural science but is an extension of them. This does not, of course, invalidate the value of the "inside out" approach to group relations in industry.

Mr Fogarty's book is very readable and is well annotated. He does not claim originality for the material presented but rather for its method of presentation. E. S. HISCOCKS

The Protozoa, Sarcodina

By Margaret W. Jepps (*Edinburgh, Oliver and Boyd, 1956, vii+183 pp., 30s.*)

Dr Jepps has written a readable and balanced account of the group of Protozoa which include the *Amoebae* (some of which are important parasites of man as well as symbionts in our laboratories), the Foraminifera and Radiolaria with their long geological record; and the Mycetozoa, which are claimed also as plants by the botanists, under the name of Myxomycetes. Dr Jepps deals with all aspects of the lives of these animals: their structure, life history, ecological relationships, and behaviour. She also provides an introductory chapter on the Protozoa in general, which includes an admirable though brief account of their general physiology and modes of response to stimuli. There are eighty line drawings, some of them far superior to those usually found in textbooks, and a good bibliography. The book is pleasantly produced, but it is to be hoped that in a second edition the footnotes will be incorporated in the text. Protozoology is not a flourishing study in Britain, but it now seems likely to take a new turn with the use of novel methods such as electron microscopy. This book provides an excellent introduction to our present knowledge of the Sarcodina—one which senior students and junior research workers can use as a foundation for further study and research. We must hope that Dr Jepps will now give us other volumes on the flagellate and ciliate Protozoa. S. A. BARNETT

A Guide to Earth History

By Richard Carrington (*London, Chatto and Windus, 1956, xvi+240 pp., 16 double plates, 21s.*)

There are many reasons for the recent recrudescence of interest in vertebrate palaeontology. At one end of the scale is the present enthusiasm for archaeology; at the other a general veneration for great antiquity as frequently expressed by the recovery of remains of the great "pre-historic" animals.

We know now that the world is older than we had once thought and can be dated at 4000 million years. Uranium helps us to estimate the age of many layers of the earth's surface and thus of major stages in the development of life itself, whose history is revealed by the rocks. Carbon-14 and other new methods throw light upon Pleistocene chronology; and thus the emergence of man, stage by stage, can be seen against an accurate background of time. Significant discoveries have been made about the animal groups linking the fishes to amphibia, amphibia to reptiles, reptiles to birds and animals. Much remains to be discovered, innumerable tasks for the palaeontologist, the anthropologist, and the comparative anatomist; yet the outline of vertebrate evolution, for example, is clear, and studies in it are sufficiently old to have acquired a biographical history of interest and importance.

Mr Carrington has tried to show what scientists have done to unravel the secrets of earth history, how they came to do it, and their successes and failures by the way. On the whole his fluent pen has done this well. Much of the story is fascinating, and not the least of its wonder is that so many of the discoveries originated in England. Often this native fact is submerged beneath the vaster literature and the more numerous finds elsewhere, notably in the new world. The theory of recapitulation, however, is out of date and should be withdrawn from teaching.

The book is well produced and abundantly illustrated by Maurice Wilson. It can be recommended to those workers in other fields who want to know what geologists have been doing, and also to the student. W. E. SWINTON

Reliability Factors for Ground Electronic Equipment

Edited by Keith Henney (*London and New York, McGraw-Hill, 1956, 261 pp., 56s. 6d.*)

Since the war the advance of electronics has been so rapid that insufficient attention has been given to the reliability of the complex equipments now in use. In many projects, notably the use of electronics in aviation, automation, and the military services, the cost of failure of equipment is very high when expressed in terms of safety of life, wasted time, and manpower, or when the project is regarded as an economic investment. Very little material on the general concept of reliability has been published here, and this book from the U.S.A. should be of interest not only to manufacturers but also to those who are concerned with the operation and usage of electronic equipment and who therefore specify the requirements. In fact, one of the main reasons why the importance of reliability has sometimes been neglected is the lack of sufficient liaison between designer and user.

The book establishes a large number of principles in the various fields which affect reliability and operation. Much of the material is in fact the result of common-sense reasoning rather than any expression of original thought.

The definition and measurement of reliability is essentially a statistical exercise, and the vast defence programme in the U.S.A. has provided the means whereby reliable statistics can be compiled. A chapter in the book is devoted to the mathematical approach and gives enough of the basic theory of probability to enable the average technical reader to follow the arguments developed.

For the designer, there are chapters backed by statistics, on electrical and mechanical factors, on components and on interference problems. The chapter on electrical factors gives a number of examples of reliable circuits which could usefully be expanded in any future edition. The chapter on components contains a wealth of statistics on the failures of resistors, capacitors, and valves. Whilst valve failures are the more numerous, failure of other components impose the most serious drain on available maintenance capacity.

There is an extremely interesting chapter on what are now known as the human engineering aspects of design. The operator is regarded as an integral part of the equipment or system which he is working, and problems involving vision, audition, and physical movement are discussed. These include consideration of body measurements in relation to seating and movement, the presentation of information, the layout and nature of physical controls and other factors affecting operation. The effect of temperature and ventilation on operator performance is also discussed.

The book is eminently readable, the diagrams and statistical tables are well presented, and each chapter has a useful bibliography. Indexing and nomenclature follows American practice. J. C. FARMER

The Horse in Blackfoot Indian Culture

By John C. Ewers (*Washington, Smithsonian Institution, Bureau of American Ethnology, Bulletin 159, United States Government Printing Office, 1955, xi ASC pp., 17 plates, 32 figs.*)

Our modern world accepts the fact of rapid technological changes—the agrarian and industrial revolutions, nuclear fission, automation—and many of our social stresses, as well as benefits, spring from them. We may forget that in remoter periods of history or prehistory, or in simpler societies in the present era, technological changes have occurred which have been no less striking in their effects upon the mode of life of the communities in which they happened.

With wide recourse to historical material, as well as his own investigations, Mr Ewers' book documents such a change. This was the introduction of the horse into the Blackfoot

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Indian tribe of the Great Plains of North America.

Before 1750 the Blackfeet were nomadic hunters and collectors, wandering over the plains of what is now Alberta and Saskatchewan, living on wild plants, augmenting their diet by periodic communal hunts of buffalo, and transporting their meagre possessions by means of dog and travois. But more than a century before, Spanish colonists had brought horses to what is now the south-western United States, and during this time more southerly Indian tribes had bought, stolen, or captured horses. Between 1750 and 1800 this diffusion had reached the northern part of the Great Plains, and the Blackfeet took to the horse.

Its effects on their social and economic organisation were striking. Buffalo hunting became easier, and could be extended into the winter, formerly a period of near-starvation. Wider tribal aggregates were formed; swifter means of communication and greater pressure on resources forced them into military aggression. At the same time, more effective distribution of resources to the unfortunate could be organised. Formerly women, on whose fertility and domestic skill the good fortunes of small nomadic groups largely depended, had been the object of slave raids. These were abandoned in favour of horse raiding, and women now led an easier life on terms of greater equality with men. The possession of more, or less, horses became the basis of a rudimentary and fluctuating class structure, within which social mobility hinged upon prowess and success in horse raiding. A technical apparatus of horse breeding and management, and the manufacture of equipment grew up, and a finer degree of specialisation followed. Finally the hazards of the chase and the raid, and of the maintenance of herds, meant that the horse featured prominently in magico-religious ceremonies.

But this technological advance had in it the seeds of its own decay. By 1880 the major subsistence resource, the buffalo, was well-nigh exterminated by the Indians, assisted in large measure by the guns of American settlers. The military organisation of the Plains Indians called for punitive measures by the Government. Finally, the major part of the Blackfeet were settled on Reservations in Montana, and the virtual extinction of the Indian horse, as it was now called, followed hard on the extermination of the buffalo.

From this relatively brief period of efflorescence in Blackfoot Indian culture, due entirely to their acceptance of what was for them a major technological change, there survived into the present century a small but precious legacy. Raised from a hunting and collecting stage of culture into that of pastoralism, pure-blood Blackfeet now make their living by raising cattle and sheep. The martial virtues which developed in five generations of horse-culture were translated into a marked readiness to serve in the United States Army in two world wars.

DERRICK J. STENNING

Dawn in Andromeda

By E. C. Large (*London, Jonathan Cape, 1956, 282 pp., 15s.*)

Inevitably, in the class of Science Fiction, this book can yet take its place with modest assurance beside the classics of Defoe and Swift, of Wells and Stapledon, for it is a lesson and a sermon as well as a formal invocation of gods outside the machine. To the sorrow of many addicts, the power of scientific romances seems to be dwindling and larger doses are ineffective, even nauseating. The author of "Dawn in Andromeda" has succeeded in evoking from a formal and familiar situation a vital and vivid drama which modern scientific education and pulp robots have almost succeeded in stifling. Anyone who tries to turn the products of our schools and universities into experimental thinkers must realise that, with a few splendid exceptions, scientific teaching is rapidly becoming a proprietary compound of technology and superstition. This novel should gently purge the system of contemporary cant and complacency without destroying the natural greed for novelty and adventure.

The author invokes a critical but good-humoured god to transport five men and five women from England to a planet of terrestrial character somewhere in the galaxy of Andromeda. At the same time the Deity implants in these pioneers a sub-threshold compulsion to build a seven-valve all-wave superheterodyne wireless set (as the peak of earthly ingenuity) from raw materials within a generation. The characters are allowed a clear memory of their various trades and professions, blacksmith, botanist, and so forth, but no sharp image of the Earth except a deep distrust of priests and politicians—and a horror of listening to the wireless. Their peculiar ambition is therefore entirely formal and even perverse; there is no light music of the spheres, least of all any yearning to regain touch with any part of the solar system. The first twenty years are spent in learning how to survive, how to make love without making enemies, and how to educate their children. Their planet is well stocked with life at all levels below human—mischievous tarsiers are the only Primates—and minerals to be won the hard way. From time to time, when the community is in a particularly exuberant mood they are severally reminded by the Gambler that Time and Chance happen to all men, by the catastrophic fall of a meteorite. Step by step they learn how to cultivate food plants, to smelt ore, build boats, teach mathematics, frame and administer laws, and finally to make a vacuum tube. As their children grow up treachery and power lust divide the younger generation so that their God-given compulsion is almost forgotten except by the surviving elders. Most sinister of all human traits, the ancient awe of myths and mysteries coupled with make-believe and play-acting all but corrupt the subtle integrity of their purpose. Characteristically, their salvation in the eleventh hour is achieved by a woman's passion and impetuosity, so that in the nick of time the conjuring tricks and fancy dress of the high priest are supplanted by the true divine magic of the legendary superheterodyne receiver "with two-way interpenetration".

Some may find here just another intricate and eccentric allegory, others a useful but untidy synopsis of the history of science and technology. These indeed it is, but there is also an assembly of real characters, named from the back of an old "Encyclopædia Britannica" one of them remembers. The Smith, Sars Sorc and his mate the gentle Mary Mus, the sage and exuberant Doctor Game Gun, the vivid temperamental witch Jere Libe, all live and suffer, love and mourn and finally triumph by the expense of personal experience, not by gratuitous miracles or vain conceit.

W. GREY WALTER

Chemistry and Mode of Action of Plant Growth Substances

Edited by R. L. Wain and F. Wightman (*London, Butterworth, 1956, 312 pp., 55s., New York, Academic Press Inc.*)

Some of the most important recent advances in plant physiology have been in the study of plant growth-regulating substances, which are widely used in practical agriculture and horticulture and are thus receiving attention from botanists, chemists, and agriculturalists. International conferences devoted exclusively to these important substances become more and more frequent. The first was held in 1937, the second in 1949, and the third in 1953. The formal papers delivered at the fourth conference held at Wye College, University of London, in July 1955, are now published.

Section I deals with the naturally occurring auxins, their extraction, identification, metabolism, and some aspects of their physiology. Paper-partition chromatography has recently contributed greatly to our knowledge. New techniques enable us to combine the analytical advantages of this method with a sensitivity surpassing that of the *Avena* curvature test (Dr Nitsch, Harvard).

Section II is on chemical structure and biological activity. The extension of systematic activity-testing to organs and tissues other than those of the classical auxin assays, the broadening of these investigations to include the so-called "antiauxins", the synthesis of new active molecules of widely divergent chemical structure have all contributed to a reorientation of our views, and we are obviously at the beginning of an important new phase of discovery.

Section III, on metabolism and mode of action, contains a miscellany of seven papers, perhaps the most important being that of Prof. T. A. Bennet-Clark, who proposes new possibilities for auxin action in the cell wall by suggesting that chelation and possibly methylation might be involved.

Section IV contains only two papers, the reports of an evening discussion on the value and interpretation of the analysis of auxin-induced growth in terms of enzyme kinetics.

This is not a textbook, or even a symposium volume in the true sense of the word. It is a compilation of research articles, a number of which have appeared or will be appearing later, in more detail, in various botanical and chemical journals. The value of such a publication seems doubtful. The great importance of a small specialised conference such as this is that it gives facilities for the free interchange of ideas and the opportunity for advancing unorthodox and consequently stimulating views perhaps with little experimental backing. Such activities are apt to be completely stultified if the contributor has previously and for all time to commit his possible indiscretions to print.

Technically the book is excellent. All research laboratories engaged on growth-substance studies will need it for reference.

L. J. AUDUS

Brief Notes

The absence of sovereignty over the high seas does not mean the absence of law. "A Chart for all the Oceans", a United Nations Review Reprint, New York, 15 cents, discusses problems engaging the attention of jurists of the International Law Commission. There is a special section on FAO's work in Chile, and on loans from the International Bank for improvement of seaports and harbours.

Reviews of research projects occupy most of the bulky Report of the Rothamsted Experimental Station for 1955. These deal with physics, chemistry, pedology, soil microbiology, botany, biochemistry, plant pathology, nematology, insecticides and fungicides, entomology, bees, and so forth.

The Morgan Crucible Company have published an attractive illustrated book giving the history of a hundred years of their works in Battersea.

The first issue of the new *Journal of Fluid Mechanics*, published by Taylor and Francis Ltd., Red Lion Court, Fleet Street, London, E.C.4, appeared in May, under the editorship of Dr G. K. Batchelor, and priced at £1 per part. The issue includes articles on collision of drops in turbulent clouds, on drift, and on the thrust due to an air jet flowing from a wing placed in a wind tunnel.

The seventh edition of the Ministry of Agriculture's Bulletin No. 37, "Silage" (H.M.S.O., 3*s*. 3*d*. post free) describes various methods of making silage in temporary or permanent silos.

The August–September issue of the French journal *Atomes* is devoted to Marine Research. Pierre Drach writes on "Biologie Littorale en Scaphandre Autonome", Francis Bernard on "L'Etude des Animaux Nageurs", J.-M. Peres on "Les Grands Fonds de la Méditerranée", and Mme F. Bernard on "Le Plancton Marin, son importance économique".

DSIR's manifold research responsibilities could not be better demonstrated than by listing the numerous reports recently published by them: "Road Research 1955" (9*d*. post free), "Food Investigation 1955" (4*s*.), "Fuel Research 1955" (4*s*. 3*d*. post free), "Report of the Forest Products Research Board 1955" (4*s*. 6*d*.), "Pest Infestation Research 1955" (4*s*.), "Mechanical Engineering Research 1955" (4*s*.).

"Our Smallest Servants", a popular survey of fermentation in the service of mankind, is published by the American domestic company of the Pfizer organisation. As long as stocks last copies will be sent to any grammar school, university, or institution librarian, or to any individual concerned with scientific education. Application should be made to Pfizer Ltd., 137–9 Sandgate Road, Folkestone, Kent.

LETTERS TO THE EDITOR

Films and British Universities

Sir:

A central institute of scientific cinematography has naturally many advantages, but, as you point out correctly, there are also certain disadvantages if it is not properly organised. There appears to be a misunderstanding in your Editorial (DISCOVERY, July, p. 265), which I would like to correct. The university experts (*Hochschulfilm referenten*) are not on the staff of the Central Institute of Scientific Cinematography, but are academic teachers, recognised authorities in their own field, and appointed by their universities as film experts. They therefore occupy an intermediate position between the Central Institute and the university. These university film experts attend a yearly conference in Göttingen, but the Central Institute does not give any direction to these experts. In my opinion it would be entirely wrong if each film project of a university were to be carried out by the Central Institute. The only interest of the Central Institute is to help with those projects which the individual university cannot carry out because of lack of experience or of skilled operators.

Furthermore the Institute is anxious to place individual universities in a position where they are able to make their own research films. For this very purpose the Institute at Göttingen holds two annual courses for university professors and academic staff in which the techniques of scientific cinematography are taught. Up to the present over a hundred have attended these courses, which have thus helped universities materially in making their own research films. In addition, an advisory service has been set up at the Central Institute to give help in film production. Several times a year a member of this service visits university departments where films are made and suggests to them the best photographic and scientific techniques available. Naturally this advisory service is carried out on a completely voluntary basis. So far it has proved extremely valuable, and is called upon more and more frequently by universities.

I hope that in future each university will as a matter of course have its own cine cameras and expert staff. The function of the Central Institute will therefore become more limited. It will then remain in an advisory capacity, and will carry through only those projects for which individual universities are not equipped.

The annual courses as well as the advisory service have led to an increased interest in scientific film matters and to an improvement in their quality. Furthermore it is pleasant to note that universities have made their own films available to the Central Institute for publication, and this has resulted in a steady availability of new and good films. These principles of organisation, which tend toward decentralisation, have also proved of great value in the building up of the "Encyclopædia Cinematographica".

I should naturally be delighted if a Central Institute of Scientific Films could be set up in Great Britain which would deal with the whole field according to either American or German experience.

G. WOLF.
Director.

Institut für den Wissenschaftlichen Film, Göttingen.

Sir:

I read with interest your remarks on "Films and British Universities" in the July issue of DISCOVERY, p. 265.

For some time I have been acquainted with the work of the British Universities Film Council, and have watched with interest developments at the University of Bristol. During my recent visit to London I was impressed with the enthusiasm for a university-level programme for the education of young film makers, on both the technical and the theoretical levels. I found such enthusiasm among both educators at the University of London, for example, and among those film producers to whom I talked in Soho Square.

Your idea of industry support for film production and training in the university should capture the imagination of at least certain British film makers. In the United States a gradually increasing amount of industry support has been enjoyed by universities making films, especially the University of California at Los Angeles. Many of the members of the University Film Producers Association are also members of the Society of Motion Picture and Television Engineers. Prominent film makers from Hollywood lecture to students in the schools mentioned above. The Screen Directors Guild makes an annual award to the producer of the best university film of the year.

I realise that the development of a single centre for the production of scientific films might be the answer in England. At the same time, I am sure you would agree that the camera, to be as effective as the microscope in the pursuit of scientific truth, must also be as accessible. It would seem that unless the making of a research film becomes an integral part of the whole research process in a number of centres, such films will seldom gain the wide currency and acceptance they should have.

My thought, in short, is that the local use of the camera should everywhere be encouraged. Where very highly specialised or extremely expensive equipment is involved, a system of equipment interchange between research centres might be evolved. The same might be true of personnel. Some of this is going on between university film units in the United States. Certain universities with sound recording facilities, for example, are doing work for sister universities who have none. All universities with sound recording facili-formation. The resources, both technical and human, made available by such a system, it would seem, would be much richer, and the general incentive greater, than if all work were completely centralised in a single production centre.

This, I realise, is only a theoretical analysis of the situation. The conditions in England may well make the centralised production centre more practicable. Perhaps a central production advisory centre with facilities for instigating and completing film projects, could be developed to co-ordinate the work of a number of local production centres. However, I do feel that the use of film must be integrated with research wherever it goes on, since film is both a means of reporting the truth, and a basic method of finding it.

ROBERT W. WAGNER.
President, University Film
Producers' Association.

Department of Photography,
Ohio State University, Columbus, Ohio.

FAR AND NEAR

A New Unidentified Growth Factor

At present there are several unidentified growth factors under investigation, most of them in commercial animal feeds derived from natural sources, such as: the whey factor, the grass juice factor, and the fish factor. All three are nutrition factors over and above those already known in their particular medium. A new one has recently been added to the list—the so-called "Vigo Factor", so named because it was discovered at the experimental farm run by the firm of Pfizer at Terre Haute in Vigo County (Indiana). After four years of intensive investigation the Pfizer research team were able to produce the new growth factor in commercial quantities by fermentation, and for some time it has been available (in the U.S. only) as a commercial animal feed concentrate (VIGOFAC).

The workers have established that the Vigo Factor is not an antibiotic, nor any one of the unidentified growth factors present in fish meal, whey, distillers' soluble, and similar sources. Repeated tests indicate that the new factor does not possess antibacterial action.

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Classified Advertisements

OFFICIAL APPOINTMENTS

MINISTRY OF LABOUR AND NATIONAL SERVICE: H.M. INSPECTORS OF FACTORIES (CLASS II). The Civil Service Commissioners invite applications from men and women for pensionable posts. Age at least 21 and (unless exceptionally well qualified) under 30 on June 1 in the year of application with extension for regular service in H.M. Forces. London salary (including extra duty allowance where payable) £533 (at age 21), then according to age up to £708 at 26 or over, rising to £969. Somewhat lower outside London. A special increment of £25, within the scale, is granted after passing probation. Higher posts filled by promotion from Class II. Pay and conditions of service are under review.

Duties include the enforcement of the provisions of the Factories Acts and Regulations affecting the safety, health, and welfare of work-people and extend to all manufacturing industries and to certain other places, including docks, works of engineering construction, and building operations.

Candidates must normally be university graduates, preferably in Engineering or Natural Science (or comparable technical qualification, e.g. A.M.I. Mech.E.). Graduates in other subjects, including Arts, are eligible. Works or other practical experience an advantage. Candidates without degrees (or comparable technical qualifications) who have good general or technical qualifications, and have had considerable works or other practical experience (especially in responsible positions) will also be considered.

Application may be made at any time, and so long as there are vacancies suitable candidates will be interviewed.

Particulars from Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 280/15.

EXPERIMENTAL OFFICERS AND ASSISTANT EXPERIMENTAL OFFICERS in various Government Departments. The Civil Service Commissioners invite applications for pensionable posts.

The posts are divided between following main groups and subjects (*a*) Mathematical and Physical Sciences, (*b*) Chemistry and Metallurgy, (*c*) Biological Sciences, (*d*) Engineering subjects and (*e*) Miscellaneous (including, e.g. Geology, Library and Technical Information Services).

Age limits: For Experimental Officers, at least 26 and under 31 on December 31, 1956; for Assistant Experimental Officers at least 18 and under 28 on December 31, 1956. Extension for regular service in H.M. Forces. Candidates aged 31 or over with specialised experience for Experimental Officer posts may be admitted.

Candidates must have at least one of a number of specified qualifications. Examples are Higher School Certificate, General Certificate of Education, Scottish Leaving Certificate, Scottish Universities Preliminary Examination, Northern Ireland Senior Certificate (all in appropriate subjects and at appropriate levels), Higher National Certificate, University degree. Candidates taking their examinations in 1956 may be admitted. Candidates without such qualifications may be admitted exceptionally on evidence of suitable experience. In general a higher standard of qualification will be looked for in the older candidates than in the younger ones.

Salary (London):

Experimental Officer £925–£1135 (men); £836–£1015 (women).

Assistant Experimental Officer £365 (at age 18) to £805 (men), £715 (women). Starting pay up to £655 (men) or £627 (women) at 26 or over. Somewhat lower outside London. Promotion prospects. Women's scales being improved under equal pay scheme.

Opportunities for further education.

Further particulars for which you are advised to make early application, from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting No. S94-95/56.

ASSISTANTS (SCIENTIFIC): The Civil Service Commissioners invite applications for pensionable posts.

Age at least 17½ and under 26 years of age on January 1, 1956, with extension for regular service in H.M. Forces, but candidates over 26 with specialised experience may be admitted.

Candidates must produce evidence of having reached a prescribed standard of education, particularly in a science or mathematical subject. At least two years' experience in the duties of the class gained by service in a Government Department or other civilian scientific establishment or in technical branches of the Forces essential in one of the following groups of scientific subjects:

(i) Engineering and physical sciences.
(ii) Chemistry, bio-chemistry and metallurgy.
(iii) Biological sciences.
(iv) General (including geology, meteorology, general work ranging over two or more groups (i) to (iii) and highly skilled work in laboratory crafts such as glass-blowing).

Inclusive salary scale £340 (at 18) to £635 (men) or £561 (women). Starting pay up to £460 (men) or £424 (women) at 25. Women's pay subject to improvement under equal pay scheme. Somewhat less in provinces. Opportunities for promotion and for further education.

Further particulars, for which you are advised to make early application, from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting No. S.59/56.

FEDERATION OF NIGERIA

GEOLOGIST (GEOPHYSICS)

Qualifications

Good honours degree in applied geophysics with geology or physics as subsidiary subjects or good honours degree in geology with post-graduate training and experience in applied geophysics. Some knowledge of electronics and ability to maintain apparatus added advantages.

Duties

To conduct geophysical surveys, chiefly in connexion with ground-water but also with the engineering geology of dam-sites, foundations, etc. Most of the work at first will be with electrical resistivity methods but magnetic and shallow seismic surveys may be undertaken later. Radioactivity surveys and electric well-logging may also be undertaken.

Terms of appointment

On (1) permanent and pensionable, or (2) contract/gratuity terms with emoluments in the scale (1) £876–£1680 p.a., (2) £1008–£1824 p.a. (1) and (2) Outfit allowance. Free passages. Quarters provided at rental. Free medical attention. Generous leave. Income tax at local rates.

Apply to Director of Recruitment, Colonial Office, London, S.W.1. State age, qualifications and experience. Quote BCD 105/14/03.

GOVERNMENT OF SIERRA LEONE GEOLOGIST

Qualifications: 1st or 2nd Class (Upper Division) Honours Geology degree. Preference will be given to candidates with experience in an alluvial diamond field.

Duties: Geological examination and mapping of the diamond deposits of Sierra Leone together with special reference to the areas now being opened up under the Diamond Licensed Mining Scheme. Description of these areas and the preparation of a report and eventually a bulletin on these deposits.

Terms of appointment: on (1) permanent and pensionable or (2) contract/gratuity terms. Emoluments in the scale (1) £922–£1652 p.a. and (2) £996–£1857 p.a. and gratuity on satisfactory completion of contract. (1) and (2) Outfit allowance. Free passages. Quarters provided if available at rental. Free medical attention. Generous leave. Income tax at local rates.

Apply to Director of Recruitment, Colonial Office, London, S.W.1. State age, qualifications and experience. Quote BCD 105/15/01.

APPOINTMENTS VACANT

GERMANIUM POWER RECTIFIERS

The English Electric Valve Co. Ltd.
Chelmsford

require an ENGINEER for the evaluation and testing of Germanium Power Rectifiers.

Applicants should be prepared to work on their own initiative and the post involves liaison with customers and the assessment of the suitability of such devices for various applications.

Applications giving full particulars of age, education and experience should be addressed to

Dept. C.P.S., 336/7 Strand, W.C.2, quoting Ref. D 1502C.

NORTH LINDSEY TECHNICAL COLLEGE

Kingsway, Scunthorpe, Lincs.

Principal:
F. C. JONES, B.Sc.(Eng.), A.M.I.Mech.E., A.M.I.E.E.

Applications are invited for the following appointments:

(*a*) Fitter-Turner for general machining and fitting in connection with the manufacture and maintenance of a wide range of apparatus and equipment. The appointment offers interesting work with good conditions to the right type of applicant. A good apprenticeship and possession of a City and Guilds Intermediate Certificate in Machine Shop Engineering would be useful recommendations. Salary £9 14*s*. 4*d*. per 44-hour week. Duties to commence as early as possible.

(*b*) Laboratory Steward for general laboratory duties in the Engineering and Building Departments. Previous experience in the preparation and maintenance of this type of apparatus and equipment is essential. Possession of a National Certificate or City and Guilds Certificate in an appropriate subject would be a recommendation. Salary and conditions in accordance with Miscellaneous, Div. III of N.J.C. Scale, i.e. £445 rising to £510 p.a. by three increments of £15 and one of £20. Duties to commence as early as possible.

Apply by letter to the Principal, at the above address, as early as possible, giving full details of age, experience and qualifications, copies of two recent testimonials, and the names of two persons for confidential reference.

ATOMIC POWER

PHYSICS AND PHYSICAL CHEMISTRY

Graduates preferably with Ph.D. in Physical Chemistry, or with honours degree in Physics, are required for new posts in research and development in connexion with high temperature, water systems, and gas-cooled reactors with

ENGLISH ELECTRIC
Whetstone, Leics.

Please write with full details to Dept., C.P.S., 336/7 Strand, W.C.2, quoting Ref. 1816A.

GEOLOGISTS AND GEOCHEMISTS required for field work in Northern Rhodesia. University degree in geology with chemistry or physics required. Must be single and in good health. Free outward passage. Commencing basic salary dependent on experience with minimum of £894 per annum. Leave 41 days per annum accumulative up to three years. In addition to the basic salary the position carries a variable cost of living allowance (at present £5 4*s*. per month) and variable copper bonus (at present approximately 70% of basic salary), field allowance and pension, life assurance and medical schemes. Applicants should state age, qualifications, experience, availability and references to R.13, Mine Employment Department, Selection Trust Building, Mason's Avenue, Coleman Street, London, E.C.2.

THE RESEARCH LABORATORIES of THE GENERAL ELECTRIC CO. LTD., North Wembley, Middlesex, have the following vacancies for graduates with a good honours degree:

(*a*) PHYSICIST OF PHYSICAL CHEMIST to work in the field of large area germanium and silicon functions, and on the development of semiconductor rectifiers. Some previous experience on semiconductors is desirable.

(*b*) PHYSICIST OF ELECTRICAL ENGINEER for work on establishing techniques for measuring the characteristics of semiconductor power rectifiers, and for investigating problems which arise when using series-parallel assemblies of these rectifiers. Candidates should preferably have had a few years post-graduate experience.

(*c*) PHYSICIST for research work on the preparation and appraisal of ferrite inductors for telecommunications. A general degree or higher national certificate might be accepted as qualifications for this post.

(*d*) PHYSICIST who is interested in discharge phenomena, for work of a fundamental nature on light sources.

Candidates for these posts should be not older than 30 years of age, and if under 26 they must be free of National Service commitments.

Please apply in writing to the Staff Manager (Ref. RLO/99), quoting (*a*), (*b*), (*c*), or (*d*) as applicable, and giving full particulars of experience, qualifications and age.

BRITISH THOMSON-HOUSTON COMPANY LIMITED

THERE is a vacancy in the Research Laboratory at Rugby for a STAFF RESEARCH ASSISTANT to work in the Glass and Ceramic Group. A wide and interesting range of experimental work includes investigation of new materials for use in nuclear reactors. Applicants should possess G.C.E. at A level in physics and chemistry, and should not be liable for military service.

Applicants are invited to write to the Director of Research, the British Thomson-Houston Co. Ltd., Rugby, giving details of their age, qualifications, and experience, quoting reference RH.

ESSO PETROLEUM COMPANY LIMITED have a number of specific appointments in their TECHNICAL DEPARTMENT at Fawley Refinery for graduate PROCESS ENGINEERS who have specialised in CHEMICAL ENGINEERING.

The post of PROCESS ENGINEER involves Technical Advisory work embracing planning, economics, and design engineering aspects. Processes include Distillation, Catalytic Cracking, Hydroforming, Hydrodesulphurisation, Chemical Treating, Lubricating Oil Production, and associated Utilities.

There are opportunities for Management Training for promising men, and continued expansion of the Refinery ensures good prospects.

It would be an advantage for Applicants to have experience in petroleum or allied industries.

Starting salaries are based on age, qualifications, and experience. There is a comprehensive Pension Scheme.

Applications will be received in strict confidence and should be addressed to Employee Relations Superintendent, ESSO PETROLEUM COMPANY LIMITED, Refinery Department, Dept. D., Fawley, Southampton.

FAR AND NEAR—continued

In chickens response to the Vigo Factor is an increase of from 5 to 12% in terms of growth; in turkeys it is about 6%; and in pigs, from 15 to 20%. As with antibiotic additives, a protein-sparing effect is observed. For the present the presence and quantity of the Vigo Factor in the animal feed concentrate produced in the Pfizer fermentation tanks can be determined by bio-assay only, that is by measuring the growth response and the improvement in feeding efficiency directly in chickens, turkeys, and pigs.

Fish in Antibiotic Ice

According to UNESCO, antibiotics may preserve fish caught at sea twice or three times as long as is possible with present methods, and enable trawlers to make longer trips. In California, experiments using fourteen different antibiotics showed varying degrees of efficiency, but, in every case, fish preserved in treated ice had a much lower spoilage rate. In Canada scientists have carried out successful experiments with salmon caught off Vancouver Island, storing them in flaked ice containing a very small amount of aureomycin. Researches have also been carried out in Denmark, the German Federal Republic, Japan, the Netherlands, Norway, and the United Kingdom by DSIR.

Before antibiotics are used commercially in preserving fish, this method must be proved completely safe for the consumer.

Radio-telescope for Germany

The first big radio-mirror telescope in West Germany is now being built on the top of the 1450-foot Stockert Mountain near Münstereifel. It will belong to the University of Bonn. The telescope will have a parabolic mirror made of light metals weighing 20 tons, and a diameter of 83 feet. The mirror, fitted to a 50-foot concrete tower, will be able to move in a full circle and will thus be able to follow every movement of the stars. A receiver installed in the tower will amplify the high-frequency signals and register their intensity automatically. The telescope is being built in order to examine the expanded dark clouds of hydrogen which fill space between the stars.

The 50-ft. concrete tower of the German radio-telescope. This will house the amplifying and recording apparatus.

Radar for All-size Craft

Kelvin Hughes hope that their new Marine Radar Type 14 will prove a useful piece of equipment for ships of all sizes and types, even to small fishing craft. Its slotted waveguide scanner eliminates the necessity for the conventional reflector, and the use of this system considerably reduces wind resistance and weight. The electrical characteristics have been improved, and side-lobe echoes are eliminated. In the transmitter unit two pulse lengths are used to provide solid paints at the longer ranges and crisp clear pictures on the short ranges. The display unit has been made suitable for deckhead, bulkhead, or deck pedestal mounting. An ingenious method of printed wiring technique has been used, and all units are quickly removable for servicing and replacement.

Hungarian Cosmic-ray Research

Hungarian cosmic-ray research has been favourably commented on by scientists abroad, and this year the international conference of scientists working on cosmic-ray research will meet in Budapest.

Two achievements of their atomic physics department are the construction of a 4,500,000-volt Van de Graaf accelerator, of which there are only a few in Europe of similar performance, and the working out of the fissioning cross-section of uranium and thorium. The radiology department of the Institute has constructed an apparatus which measures a millionth of a microgram. The leading research workers of the Institute regularly publish their work in *Acta Physica*, the foreign language periodical of the Hungarian Academy of Sciences.

Nuclear Physics Institute in Tashkent

The U.S.S.R. Council of Ministers has decided to establish in Tashkent a nuclear physics institute of the Academy of Sciences of the Uzbek S.S.R.

The Institute will conduct research on fundamental problems of nuclear physics and will deal with the application of tracer atoms in biology, chemistry, medicine, and technology. It will be fitted out with an experimental atomic reactor and the necessary equipment and apparatus for research on nuclear physics.

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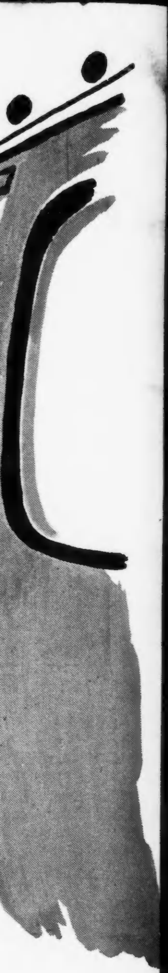

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